

# A Catalog of Solutions







# A Catalog of Solutions

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# Where Fluke Solutions Fit

In over 200,000 organizations worldwide, you'll find Fluke equipment solving tough test, measurement, and control problems. In the R & D Lab. Throughout production. In calibration. And out into the field.

Whether your business is computers or chemicals, cars or components, you'll get quality products backed by a 36 year tradition of technical leadership. And you get the support of 2700 employees and 62 service centers in 44 countries.

These two pages summarize typical applications where you'll find Fluke products. The remainder of the catalog details product features and specifications.

Put the Fluke solution to work for you. Call your nearest Fluke sales office or representative listed on pages 243-247.

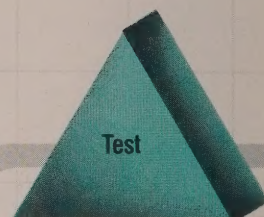
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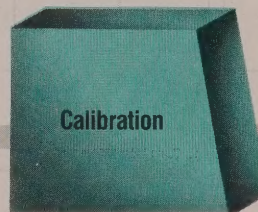


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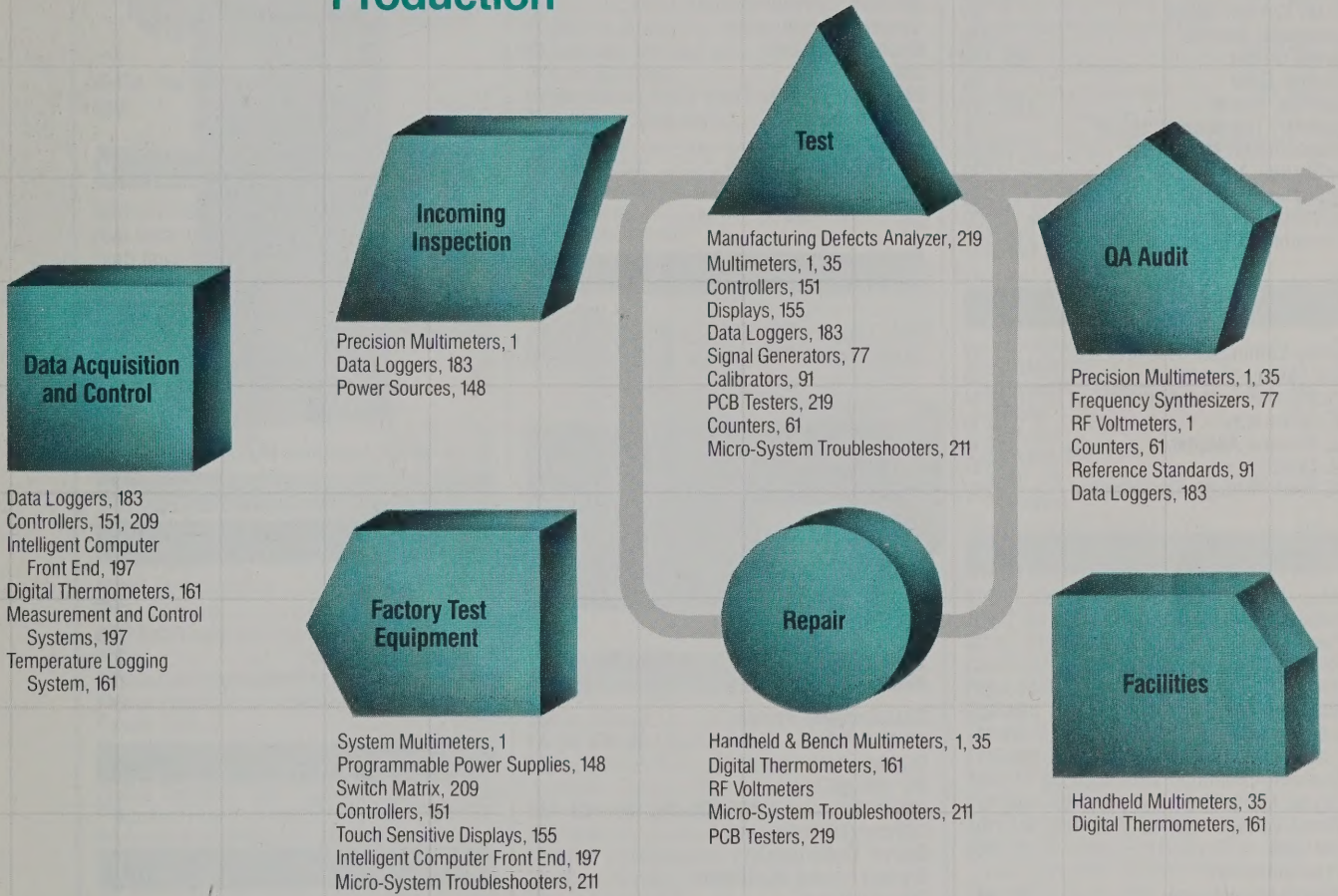
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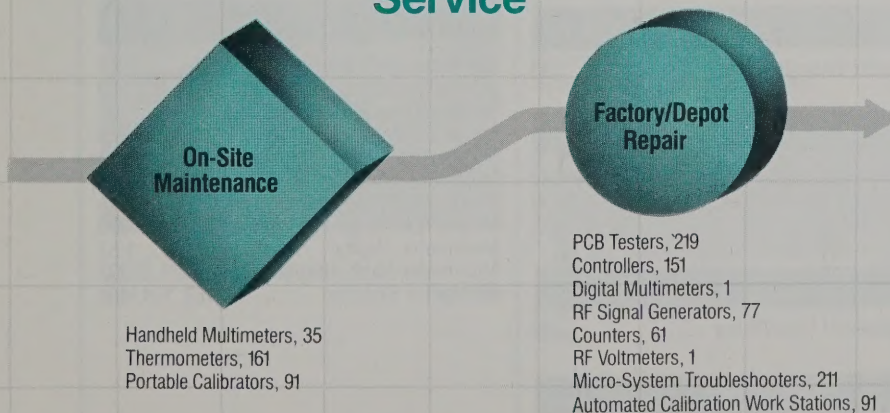
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## Service





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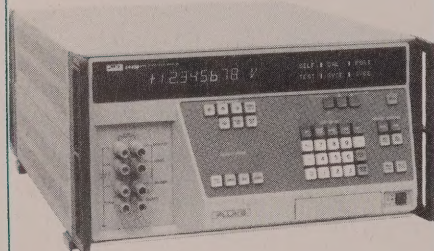
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5440B Direct Voltage Calibrator

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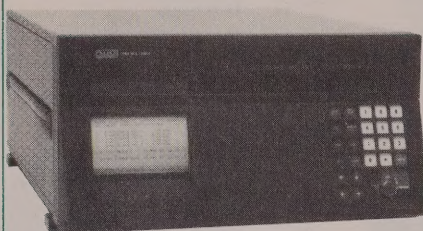
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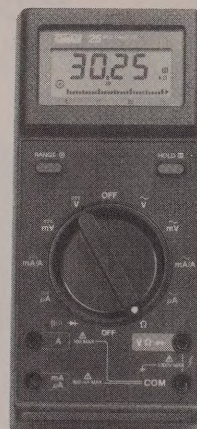
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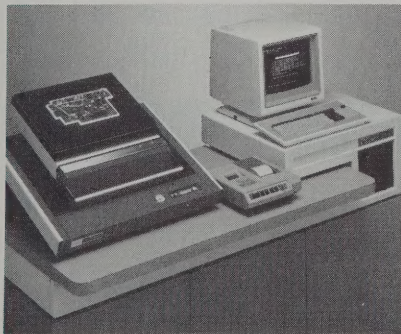
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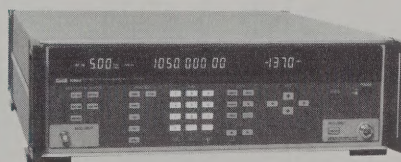


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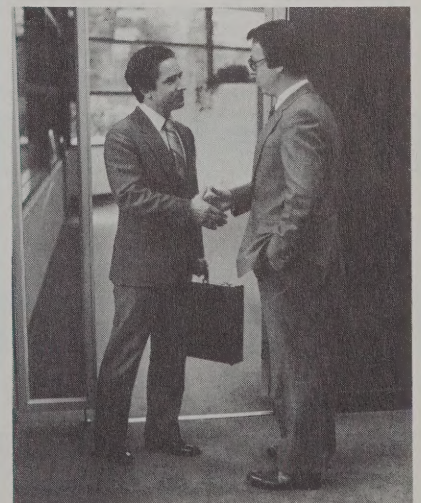


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# DIGITAL MULTIMETERS and VOLTMETERS

## Introduction

Digital Voltmeters (DVMs) and Digital Multimeters (DMMs) are being employed in ever increasing numbers by professionals for industrial and research applications. Compared to other voltmeters and multimeters, DVMs and DMMs offer better speed, accuracy, resolution, and automatic readout. As a result, they reduce operator fatigue and errors.

Fluke DMMs range from inexpensive, handheld models to complex units for the most sophisticated systems applications in production or R & D.

A choice of either a 3½-, 4½-, 5½-, 6½-, or 7½-digit display provides the resolution and accuracy to fit the requirement. For recording measured data, many of the DMMs can be equipped with output interfaces.

Fluke system DVMs and DMMs feature options that expand a basic instrument into whatever is required by the

application. Accuracy and resolution will be a function of the model. System options provide remote control and data readout via equipment compatible with IEEE Std 488-1978, EIA Standard RS-232-C, or Parallel (binary) and BCD interfaces.

## Selection

To select a DMM for a given application, first determine what you will need to measure and what range is needed. Will it be dc voltage, ac voltage, dc current, ac current, resistance, ratio? And what will be the degree of accuracy, resolution, speed and sensitivity needed? Then consider the operating environment for restrictions on size and power (line or battery). Many new speed, convenience, and simplicity features are found in Fluke Handheld DMMs.

Calibration requirements, reliability, and cost must also be considered. The accompanying table compares the bench and system lines of Fluke digital voltmeters and multimeters.

For a comparison of Fluke handheld DMMs see the chart on page 35.

## Selection Guide

Models	Basic Features			Special Features			Interfaces			DC Volts			AC Volts			AC/DC Amps			Ohms, etc.			Page		
	Max Number of Digits	Display	Autoranging	Burst Memory	dB, dBm Readout	Offset/Relative Ref	Touch-Hold	IEEE-488	RS-232-C	Parallel/BCD	Basic Accuracy	Max Resolution, $\mu V$	Max Voltage, w/o Probe	True-RMS	Basic 90 Day Accuracy, %	Max Resolution, $\mu V$	Frequency Range, Hz	Max Resolution, nA	Max Amps, w/o Probe	Max Resolution, m $\Omega$	Max Resistance, M $\Omega$		Diode Test	Conductance
Bench / System Multimeters																								
8505A	7½	LED	(1)	—	—	●	—	Δ	Δ	Δ	0.001	0.1	1200	Δ	0.1	1.0	1M	0.1	1.28	0.01	265	—	—	6
8506A	7½	LED	(1)	—	—	●	—	Δ	Δ	Δ	0.001	0.1	1200	●	0.012	1.0	1M	0.1	1.28	0.01	265	—	—	6
8500A	6½	LED	(1)	—	—	●	—	Δ	Δ	Δ	0.001	1.0	1280	Δ	0.1	10	1M	1.0	1.28	0.1	262	—	—	12
8502A	6½	LED	(1)	—	—	●	—	Δ	Δ	Δ	0.001	1.0	1280	Δ	0.1	10	1M	1.0	1.28	0.1	262	—	—	12
8520A	5½	LED	(1)	●	Δ	●	—	●	—	—	0.005	1.0	1000	●	0.1	10	1M	—	(3)	0.1	20	—	●	15
8522A	5½	LED	(1)	●	●	●	—	—	—	●	0.005	1.0	1000	●	0.1	10	1M	—	(3)	0.1	20	—	●	15
8840A	5½	VF*	(1)	—	—	●	—	Δ	—	—	0.004	1.0	1000	Δ	0.14	1.0	100k	10k	2.0	1.0	20	—	—	3
8860A	5½	LED	(1)	—	—	●	—	Δ	—	—	0.008	1.0	1000	●	0.15	1.0	300k	—	(3)	1.0	20	—	—	19
Bench / Portable Multimeters																								
8810A	5½	LED	(1)	—	—	—	—	Δ	—	Δ	0.008	1.0	1200	Δ	0.2	10	100k	—	(3)	1.0	20	—	—	22
8600A	4½	LED	(1)	—	—	—	—	Δ	—	Δ	0.02	10	1200	—	0.2	10	100k	10	2.0	10	20	—	—	24
8050A	4½	LCD	—	—	●	●	(4)	—	—	—	0.03**	10	1000	●	0.5	10	50k	10	2.0	10	20	●	●	29
8010A	3½	LCD	—	—	—	—	(4)	—	—	—	0.1**	100	1000	●	0.5	100	50k	100	10	100	20	●	●	32
8012A	3½	LCD	—	—	—	—	(4)	—	—	—	0.1**	100	1000	●	0.5	100	50k	100	2.0	10	20	●	●	32
Wideband True-RMS AC Digital Voltmeters																								
8920A	3½	LED	(1)	—	●	●	—	Δ	—	Δ	(2)	(2)	(2)	●	0.5	1.0	20M	—	(3)	—	—	—	—	26
8921A	3½	LED	(1)	—	●	●	—	Δ	—	Δ	(2)	(2)	(2)	●	0.5	1.0	20M	—	(3)	—	—	—	—	26
8920A	3½	LED	(1)	—	●	●	—	Δ	—	Δ	(2)	(2)	(2)	●	0.5	1.0	11M	—	(3)	—	—	—	—	26

• Standard

Δ Optional

\*Vacuum fluorescent

(1) Or manual ranging

(2) Will measure dc in ac-dc mode

\*\* 1-year accuracy

(3) Use 80J-10 or A90 Shunt for up to 10A

(4) Use 80T-H Probe



# THEORY, FEATURES & TERMS

## A-to-D Converters

Fluke DMMs employ three different a-d conversion techniques: Dual-slope integration, voltage-to-frequency conversion, and Fluke's patented Recirculating Remainder technique. Each of these techniques provides unique advantages.

The Recirculating Remainder technique features inherent high-speed conversion and short sample time. This is most useful in systems applications where speed is important.

The dual-slope integration technique is used in most portable models. It features almost total rejection of fixed-frequency noise, especially 50 Hz or 60 Hz line noise.

## AC Voltage & Current Measurements

Average-sensing ac-to-dc converters are used in some Fluke DMMs and true-rms converter used in others. The average-sensing converter is intended for sine wave measurements where little or no distortion is present. It measures the average value of the rectified sine wave and scales it to provide an rms indication. The true-rms converter is more accurate when the input waveform is not sinusoidal. The Fluke 8506A DMM measures true-rms using a fast thermal transfer technique that improves accuracy by a factor of about 9 to 1 compared to other DMMs.

When measuring ac voltage it is common to use a coupling capacitor to block dc. There is a less common need to measure the rms value of dc and ac combined. Then dc coupling is required unless both are measured separately and combined in a calculation. Use of dc coupling is called the ac+dc mode.

## Resistance Measurements

Fluke DMMs utilize both two-wire and four-wire techniques for making resistance measurements. In cases where accuracy requirements are very high and resistance values are less than about 10 k $\Omega$ , the four-wire configuration is recommended. This technique eliminates the test-lead resistance from the measured values by providing one pair of terminals for supplying current and a separate pair for sensing voltage.

## Glossary

**Autopolarity** — The polarity of the applied dc voltage or current is automatically indicated.

**Autoranging** — A mode where the instrument will automatically change to a measurement range that best suits the amplitude of the input signal to be measured.

**Autozero** — Residual voltage, current, or resistance errors near zero are automatically corrected without a front panel control.

**Burden Voltage** — Voltage drop across the input terminals when measuring current. Caused by the shunt resistance, fuse resistance, and contact resistance.

**Common Mode Noise Rejection** — Ability to measure a signal in the presence of an unwanted common mode voltage, typically expressed in decibels. For example, a common mode rejection specification of 120 dB would allow up to 1V of common mode voltage before a 1  $\mu$ V error would be seen. (120 dB = 1,000,000:1 voltage ratio). Also see Lead Unbalance.

**Common Mode Voltage** — In DMM terminology, the voltage at the Low terminal of the signal source measured with respect to the power line ground at the multimeter.

**Crest Factor** — Ratio of the peak value of an ac signal divided by the rms value. Symmetrical square waves have a crest factor of 1:1 and sinewaves 1.4:1. Other waveforms depend on shape and duty factor.

**dB** — Decibel. A logarithmic unit used to express the magnitude of a change in, or ratio of signals or sound levels. A voltage ratio of 1:10 is equal to -20 dB, and a voltage ratio of 10:1 is equal to 20 dB. It follows that a voltage ratio of 100:1 equals 40 dB, a voltage ratio of 1000:1 equals 60 dB, etc. Because electrical power (P) is proportional to voltage squared ( $E^2$ ) a power ratio of 10:1 is equal to 10 dB not 20 dB.

**dBm** — Decibel referenced to one milliwatt. A power level equal to ten times the common logarithm of the ratio of a given power ( $P_x$ ), in watts, to 0.001 watt:  $dBm = 10 \log (P_x \div 0.001)$ .

**Diode Test** — A resistance range or special mode that will force a small, forward current through a PN junction, from a supply limited to about 2 volts.

**Four-Terminal Ohms** — A method for making accurate low resistance measurements where the current-source and voltage-measurement terminals are separate.

**Guard** — An electrostatic shield used to reduce common mode currents and thereby, in effect, improve common mode rejection.

**Lead Unbalance** — Usually specified as "1 k $\Omega$  in either lead" or "1 k $\Omega$  unbalance." A way of stating how different the source impedance must be for each input lead for a common mode signal to be rejected as specified.

**MTBF** — Mean time between failures, of a repairable product.

**Normal Mode Rejection** — Ability to measure the dc component of a signal which contains both ac and dc.

**Overrange** — Capability to measure beyond a range of 1, 10, 100, 1000, etc., without having to change to the next higher range and thereby sacrifice resolution.

**Resolution** — The magnitude of an input signal equal to a one-digit change in the least significant digit in the display.

**Siemens** — Unit of conductance (S), formerly mho, the reciprocal of resistance.

**Temperature Coefficient** — A factor that shows how the ambient temperature may affect accuracy when operated above or below the temperature range where accuracy is specified.

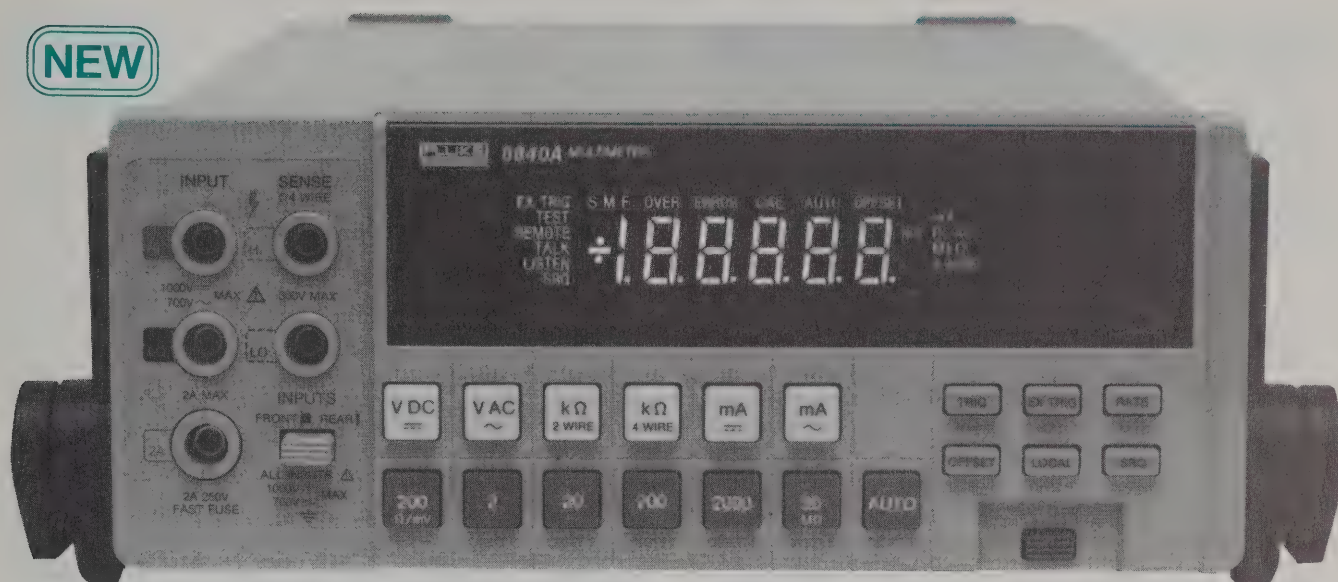
**Thermal RMS** — A means of measuring the true-rms value of ac using a fast thermal transfer technique.

**True-RMS** — Capability of accurately measuring the rms value of ac voltages and currents having non-sinusoidal waveforms as well as those having a sinewave form. Also see Crest Factor.

**Volt-Hertz Product** — The numerical result of multiplying the rms value of an ac voltage (volts) by its frequency (hertz). A way of specifying the capability of handling comparatively low voltages at high frequencies or high voltages at low frequencies.



NEW



8840A

### 8840A, Accuracy and Low Cost

- 0.005% basic 1-year dc accuracy
- Ohms and dc current standard
- Ac voltage and current optional
- Full system capability with optional IEEE-488 interface
- Up to 100 readings/second system speed
- Vacuum fluorescent display
- Closed-case calibration
- Comprehensive self test

The 8840A introduces new standards of accuracy, speed, resolution, and convenience in a 5½-digit DMM. It comes with full dc voltage, current, and resistance capabilities, vacuum fluorescent display, and offers optional true rms ac and IEEE-488 interface capabilities.

### Performance

The 8840A has performance you would expect in multimeters costing twice as much. Basic dc accuracy is 0.005% for 1 year and 0.002% for 24 hours. Basic ac accuracy is 0.16% for 1 year. See the specifications that follow for complete information on measurement ranges and accuracy.

### Closed-Case Calibration

No internal adjustments are required for calibration. After you initiate calibration via a recessed front panel switch, you are led through a software controlled procedure that even double checks to ensure that appropriate reference inputs have been applied. Calibration can be performed under front panel or IEEE-488 control.

### Self Testing

The 8840A automatically performs a digital self test each time it is powered up. Additionally, you can initiate a comprehensive analog and digital diagnostic self test from the front panel or through the IEEE-488 interface.

### Powerful System Capabilities

Adding the inexpensive IEEE-488 interface option to the 8840A provides system capability which includes complete system control of functions, ranges, and reading rates. Front or rear panel inputs are switch-selectable from the front panel (and you can sense the status of the switch over the bus). Calibration and self-test can also be controlled over the bus.

The mechanical design contributes to performance and convenience in system applications. The 8840A's metal case provides EMI shielding to ensure measurement integrity. The unit can be mounted in a half-rack slot simply by removing the handle, turning the "twist-away" rear feet, and bolting on rack-mount brackets.

Embodying all these features, the 8840A is a fully programmable, powerful digital multimeter within reach of every system builder.

### Technology

A monolithic A/D converter uses CMOS IC design to achieve the superb accuracy, speed, and reliability of the 8840A.

Analog switch ICs developed by Fluke replace discrete switching devices to create superior performance, reliability, and serviceability.

A voltage reference device similar to that found in the Fluke 732A DC Reference Standard provides unmatched stability.

Precision thin film resistor networks establish the accuracy and maintain the stability of the 8840A.



## DIGITAL MULTIMETER

8840A

## Specifications

## DC Voltage

## Input Characteristics

Range	Full Scale 5½ Digits	Resolution		Input Resistance
		5½ Digits	4½ Digits*	
200 mV	199.999 mV	1 µV	10 µV	≥10,000 MΩ
2V	1.99999V	10 µV	100 µV	≥10,000 MΩ
20V	19.9999V	100 µV	1 mV	≥10,000 MΩ
200V	199.999V	1 mV	10 mV	10 MΩ
1000V	1000.00V	10 mV	100 mV	10 MΩ

\*4½-digits at the fastest reading rate.

## Accuracy

Normal (S) Reading Rate: ±(% of Reading + Number of Counts)

Range	24 Hour* 23°C±1°C	90 Day 23°C±5°C	1 Year 23°C±5°C
200 mV**	0.003 + 3	0.007 + 4	0.008 + 4
2V	0.002 + 2	0.004 + 3	0.005 + 3
20V	0.002 + 2	0.005 + 3	0.006 + 3
200V	0.002 + 2	0.005 + 3	0.006 + 3
1000V	0.003 + 2	0.005 + 3	0.007 + 3

\*Relative to calibration standards

\*\*Using Offset control

**Medium and Fast Rates:** In medium rate, add 2 counts to number of counts. In fast rate, use 2 counts for the number of counts

## Operating Characteristics

**Temperature Coefficient:** >±(0.0006% of Reading + 0.3 Count) per °C from 18°C to 0°C and 28°C to 50°C

**Maximum Input:** 1000V dc or peak ac on any range

**Noise Rejection:** Automatically optimized at power-up for 50, 60 or 400 Hz

Rate	Readings/ Second <sup>1</sup>	Filter	NMRR <sup>2</sup>	Peak NM Signal	CMRR <sup>3</sup>
S	2.5	Analog & Digital	>98 dB	20V or 2xFS <sup>4</sup>	>140 dB
M	20	Digital	>45 dB	1xFS	>100 dB
F	100	None	—	1xFS	>60 dB

<sup>1</sup> Reading rate with internal trigger and 60 Hz power line frequency. See "Reading Rates" for more detail

<sup>2</sup> Normal Mode Rejection Ratio, at 50 or 60 Hz ±0.1%. The NMRR for 400 Hz ±0.1% is 85 dB in S rate and 35 dB in M rate

<sup>3</sup> Common Mode Rejection Ratio at 50 or 60 Hz ±0.1%, with 1 kΩ in series with either lead. The CMRR is >140 dB at dc for all reading rates

<sup>4</sup> 20 volts or 2 times Full Scale whichever is greater, not to exceed 1000V

## True-RMS AC Voltage Option (-09)

## Input Characteristics

Range	Full Scale 5½ Digits	Resolution		Input Impedance
		5½ Digits	4½ Digits*	
200 mV	199.999 mV	1 µV	10 µV	1 MΩ
2V	1.99999V	10 µV	100 µV	shunted
20V	19.9999V	100 µV	1 mV	by
200V	199.999V	1 mV	10 mV	<100 pF
700V	700.00V	10 mV	100 mV	

\*4½-digits at the fastest reading rate.

## Accuracy

Normal (S) Reading Rate: ±(% of Reading + Number of Counts)

For sinewave inputs ≥10,000 counts<sup>1</sup>

Frequency (Hz)	24 Hour <sup>2</sup> 23°C±1°C	90 Day 23°C±5°C	1 Year 23°C±5°C
20-45	1.2 + 100	1.2 + 100	1.2 + 100
45-100	0.3 + 100	0.35 + 100	0.4 + 100
100-20k	0.07 + 100	0.14 + 100	0.16 + 100
20k-50k	0.15 + 120	0.19 + 150	0.21 + 200
50k-100k	0.4 + 300	0.5 + 300	0.5 + 400

<sup>1</sup> For sinewave inputs between 1,000 and 10,000 counts, add to Number of Counts 100 counts for frequencies 20 Hz to 20 kHz, 200 counts for 20 kHz to 50 kHz, and 500 counts for 50 kHz to 100 kHz

<sup>2</sup> Relative to calibration standards

**Medium and Fast Reading Rates:** In medium rate, add 50 counts to number of counts. In fast rate the specifications apply for sinewave inputs ≥1000 counts and >100 Hz

## Operating Characteristics

**Temperature Coefficient:** ±(% of Reading + Number of Counts) per °C, 18°C to 0°C and 28°C to 50°C

For Inputs	Frequency in Hz		
	20-20k	20k-50k	50k-100k
≥10,000 counts	0.019 + 9	0.021 + 9	0.027 + 10
>1,000 counts	0.019 + 12	0.021 + 15	0.027 + 21

## Crest Factor

**Nonsinusoidal Inputs:** For nonsinusoidal inputs ≥10,000 counts with frequency components ≤100 kHz, and the following % of reading to the accuracy specifications

Fundamental Frequency	1.0 to 1.5	1.5 to 2.0	2.0 to 3.0
45 Hz to 20 kHz	0.05	0.15	0.3
20 Hz to 45 Hz and 20 kHz to 50 kHz	0.2	0.7	1.5

**Maximum Input:** 700V rms, 1000V peak or 2 x 10<sup>7</sup> volts-hertz product (whichever is less) for any range

**Common Mode Rejection:** >60 dB at 50 or 60 Hz with 1 kΩ in either lead

## DC Current

## Input Characteristics

Range	Full Scale 5½ Digits	Resolution	
		5½ Digits	4½ Digits*
2000 mA	1999.99 mA	10 µA	100 µA

\*4½-digits at the fastest reading rate

## Accuracy

Normal (S) Reading Rate: ±(% of Reading + Number of Counts)

Current	90 Days 23°C±5°C	1 Year 23°C±5°C
≤1A	0.04 + 4	0.05 + 4
>1A	0.1 + 4	0.1 + 4

**Medium and Fast Reading Rates:** In medium reading rate, add 2 counts to number of counts. In fast reading rate, use 2 counts for number of counts



**AC Current (Requires Option -09)****Input Characteristics:****AC Accuracy**

**Normal (S) Reading Rate:**  $\pm(\%$  of Reading + Number of Counts)  
1 Year,  $23^{\circ}\pm 5^{\circ}\text{C}$ , for sinewave inputs  $\geq 10,000$  counts

Frequency in Hertz		
20-45	45-100	100-5k*
2.0 + 200	0.5 + 200	0.4 + 200

\*Typically 20 kHz

**Medium and Fast Reading Rates:** In medium reading rate, add 50 counts to number of counts. In fast reading rate, for sinewave inputs  $\geq 1000$  counts and frequencies  $> 100$  Hz, the accuracy is  $\pm(0.2\%$  of reading + 30 counts)

**Operating Characteristics**

**Temperature Coefficient:** Less than  $0.1 \times$  accuracy specification per  $^{\circ}\text{C}$  from  $18^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  and  $28^{\circ}\text{C}$  to  $50^{\circ}\text{C}$

**Maximum Input:** 2A dc or rms ac. Protected with 2A, 250V fuse accessible at front panel, and internal 3A, 600V fuse

**Burden Voltage:** 1V dc or rms ac typical at full scale

**Resistance****Input Characteristics**

Range	Resolution			Current Through Unknown
	Full Scale 5 1/2 Digits	5 1/2 Digits	4 1/2 Digits*	
200 $\Omega$	199.999 $\Omega$	1 m $\Omega$	10 m $\Omega$	1 mA
2 k $\Omega$	1.99999 k $\Omega$	10 m $\Omega$	100 m $\Omega$	1 mA
20 k $\Omega$	19.9999 k $\Omega$	100 m $\Omega$	1 $\Omega$	100 $\mu\text{A}$
200 k $\Omega$	199.999 k $\Omega$	1 $\Omega$	10 $\Omega$	10 $\mu\text{A}$
2000 k $\Omega$	1999.99 k $\Omega$	10 $\Omega$	100 $\Omega$	5 $\mu\text{A}$
20 M $\Omega$	19.9999 M $\Omega$	100 $\Omega$	1 k $\Omega$	0.5 $\mu\text{A}$

\*4 1/2-digits at the fastest reading rate.

**Accuracy**

**Normal (S) Reading Rate:**  $\pm(\%$  of Reading + Number of Counts)<sup>1</sup>

Range	24 Hour <sup>2</sup> 23 $^{\circ}\pm 1^{\circ}\text{C}$	90 Day 23 $^{\circ}\pm 5^{\circ}\text{C}$	1 Year 23 $^{\circ}\pm 5^{\circ}\text{C}$
200 $\Omega$	0.004 + 3	0.011 + 4	0.014 + 4
2 k $\Omega$	0.0028 + 2	0.01 + 3	0.013 + 3
20 k $\Omega$	0.0028 + 2	0.01 + 3	0.013 + 3
200 k $\Omega$	0.0028 + 2	0.01 + 3	0.013 + 3
2000 k $\Omega$	0.023 + 3	0.027 + 3	0.028 + 3
20 M $\Omega$	0.023 + 3	0.043 + 4	0.044 + 4

<sup>1</sup>Using Offset control

<sup>2</sup>Relative to calibration standards

**Medium and Fast Reading Rates:** In medium rate, add to the number of counts 2 counts for the 2 k $\Omega$  through 200 k $\Omega$  ranges and 3 counts for the 2000 k $\Omega$  and 20 M $\Omega$  ranges. In fast reading rate, use for the number of counts 3 counts for the 200 $\Omega$  range, and 2 counts for all other ranges.

**Operating Characteristics**

**Temperature Coefficient:** Less than  $0.1 \times$  accuracy specification per  $^{\circ}\text{C}$  from  $18^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  and  $28^{\circ}\text{C}$  to  $50^{\circ}\text{C}$

**Measurement Configuration:** 2-wire or 4-wire

**Open Circuit Voltage:** Less than 6.5V on the 200 $\Omega$  through 200 k $\Omega$  ranges. Less than 13V on the 2000 k $\Omega$  and 20 M $\Omega$  ranges

**Input Protection:** To 300V rms

**Reading Rates**

**Reading Rates With Internal Trigger** (readings per second):

Rate	Power Line Frequency*		
	50 Hz	60 Hz	400 Hz
S	2.08	2.5	2.27
M	16.7	20	18.2
F	100	100	100

\*Sensed automatically at power-up

**General Specifications**

**Option -05 IEEE-488 Interface Function:** Option allows complete control and data output capability, and supports the following interface function subsets: SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, E1, PP0 and C0

**Common Mode Voltage:** 1000V dc or peak ac, or 700V rms ac from any input to earth

**Temperature Range:**  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$  operating;  $-40^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  storage

**Humidity Range:** 80% RH from  $0$  to  $35^{\circ}\text{C}$ ; 70% to  $50^{\circ}\text{C}$

**Warmup Time:** 1 hour to rated specifications

**Power:** 100, 120, 220, or 240V ac  $\pm 10\%$  (250V ac maximum), switch selectable at rear panel; 50, 60, or 400 Hz, automatically sensed at power up; 20V A maximum

**Vibration:** Meets requirements of MIL-T-28800C for Type III, Class 3, Style E equipment

**Protection:** ANSI C39.5 and IEC 348, Class I

**Size:** 8.9 cm H x 21.6 cm W x 37.1 cm D (3.5 in x 8.5 in x 14.6 in)

**Weight:** Net, 3.4 kg (7.5 lb); shipping 4.5 kg (10 lb)

**Included:** Line cord, test leads, Instruction/Service Manual, IEEE-488 Quick Reference Guide, and instrument performance record

**Model**

January 1985 prices

8840A Digital Multimeter ..... \$695

**Options**

8840A-05 IEEE-488 Interface ..... 150

8840A-05K Field Installable IEEE-488 Interface ..... 170

8840A-09 True-RMS AC ..... 150

8840A-09K Field Installable True-RMS AC ..... 170

**Accessories (Also see page 55)**

Y8834 Single Rack Mount Kit ..... 35

Y8835 Dual Rack Mount Kit ..... 75

Y8021 1m IEEE-488 Shielded Cable ..... 85

Y8022 2m IEEE-488 Shielded Cable ..... 95

Y8023 4m IEEE-488 Shielded Cable ..... 105

Y8077 Four Terminal Short ..... 30

A90 6-Range Current Shunt ..... 535

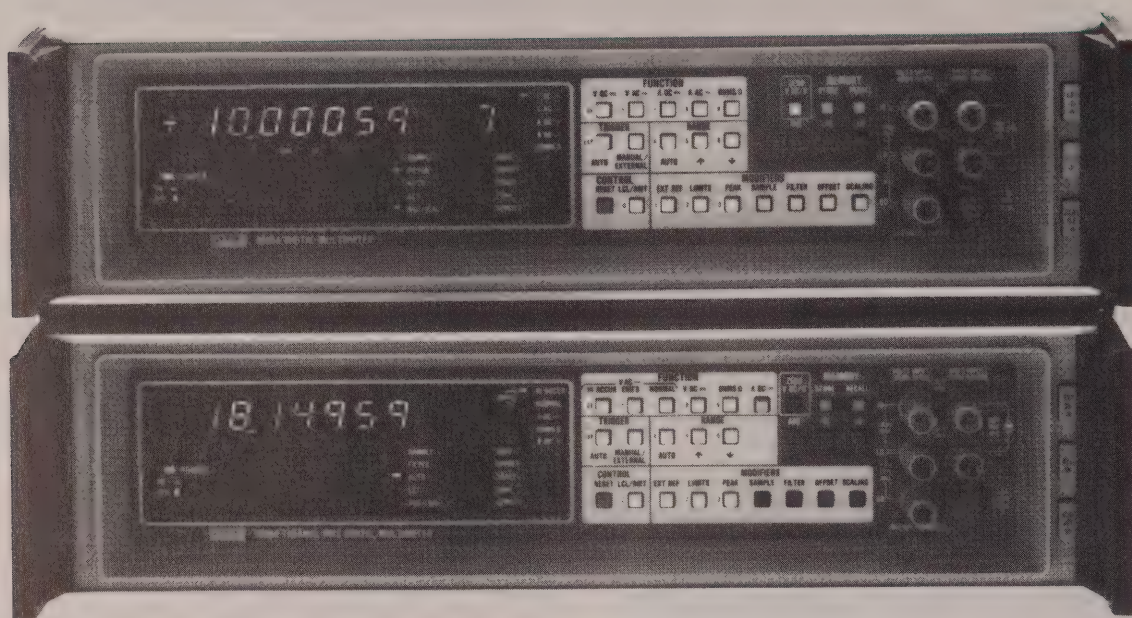
**After-Warranty Service (See page 227)**

SC1-8840A, per 90-day interval ..... 72



# DIGITAL MULTIMETERS

8506A/8505A



8506A/8505A

## 8506A Thermal RMS Digital Multimeter

- 8505A features plus
- 120 ppm ac accuracy, 40 Hz to 20 kHz
- Full accuracy for crest factors as high as 8:1
- 25 ppm short-term ac stability
- Frequency response specified to 1 MHz
- AC-DC transfer accuracies with DMM speed and convenience

The 8505A and 8506A Digital Multimeters are Fluke's most advanced bench/system DMMs. Both models excel in dc accuracy, resolution, versatility and speed.

The 8506A uses a fast thermal rms sensing technique for measuring ac which very significantly advances the state-of-the-art for ac measurements using a system DMM: It is several times more accurate than the calculating type of true-rms converter and is unmatched by any other DMM. Basic ac accuracy uncertainty is reduced to 120 parts per million for frequencies from 40 Hz to 20 kHz. That approximates the accuracy you can expect using traditional thermal transfer techniques that typically take several minutes for each measurement. Short term stability is 25 ppm. Accuracy is specified from 10 Hz to 1 MHz and non-sinusoidal waveforms having crest factors as high as 8 to 1 can be measured with full 90-day accuracy.

## Software Calibration

Both the 8506A and 8505A have a "software calibration" feature that makes it easy to store correction factors for every range of any measurement function. You can update the 24-hour accuracy specifications daily, or whenever the need arises — without having to remove the covers. Nor do you need to use a cardinal point standard for a reference. Any reference having a suitably accurate

## 8505A Digital Multimeter

- 5 ppm dc accuracy, 100 nV (nanovolt) sensitivity
- 500 readings per second with 6½-digit resolution
- AC (8505A only), ohms, current module options
- IEEE-488, RS-232-C, and parallel interfaces
- Front-rear switchable input standard in basic mainframe
- Software calibration from front panel or remote interface
- Modular construction for application flexibility

value between 60% of range and full scale will do. This "software calibration" is managed with a few keystrokes on the front panel or even remotely when used as part of a test and measurement system.

## Measurement Speed

Most system DMM manufacturers use an integrating technique for A-to-D conversion. That means there must be a compromise between resolution and reading speed. The 8505A and 8506A use a Fluke patented "recirculating remainder" technique for A-to-D conversion that does not compromise 6½-digit resolution at reading speeds up to 500 per second. Front or rear measurement inputs are switch-selectable from the front panel. For system applications the position of the switch can be sensed through the interface. An external trigger input is included to control the timing of measurements remotely. And, to control the switching time of an external scanner, scanner-advance output pulses are available at the rear panel.

Either IEEE-488, RS-232-C, or one of several parallel interface options may be used for systems applications. The parallel interfaces will work with DEC computer interfaces DR11C, DRV11, or PC11 or with HP computer interfaces 12566 or HP98032A.



## DIGITAL MULTIMETERS

8506A/8505A

## Math Power

The 8506A and 8505A are controlled by an internal microprocessor and have built in math power to add, subtract, multiply, and divide as well as store and compare numerical information. Each measurement may be made a part of a calculation before being displayed or recorded. Stored HI and/or LO limit values may be repeatedly compared to measured values to determine out-of-tolerance conditions. HI, LO, or PASS indications may appear directly in the display. The highest and lowest values in a series of measurements may be stored and later displayed. And measurements may all be in terms of  $\pm$  deviations from a stored "offset" value. In general, any calculation is possible based on the general formula.

$$Y = mx + b$$

Where  $m$  = scaling factor (multiplier),

$x$  = value measured,

$b$  = the  $\pm$  offset, and

$Y$  = the numerical result

## 8506A &amp; 8505A Differences

The 8505A is Fluke's lowest cost DMM having top dc accuracy, resolution, and speed. Two options for measuring ac voltage are available — either an ac average-sensing, rms-indicating option (-01) for sinewaves or an ac true-rms option (-09A) for either sinewaves or non-sinusoidal waveforms. An option for measuring current (-03) and an option for measuring resistance (-02A) are also available for the 8505A. For measuring ac current, an ac voltage option (-01 or -09A) must also be installed. An 8505A, when fully equipped, will measure dc and ac voltage, dc and ac current, and resistance. The 8506A and 8505A have identical dc measurement capabilities but the 8506A requires no option for measuring ac voltage. State-of-the-art ac voltage measurement capabilities are built in. An option for measuring dc current may be installed (-03) or an option for measuring resistance may be installed (-02A), but not both at the same time. Any external dc reference voltage up to 40 volts that is applied at the rear panel may be compared and the relative values displayed as a ratio. The same interface options are available for the 8506A as for the 8505A.

## 8506A Specifications

## DC Voltage

All dc voltage accuracy and stability specifications apply after a two-hour warm-up unless otherwise noted. The 24-hour specifications are relative to the calibration standards used.

## Input Characteristics

Range	Full Scale (6½ Digits)	Resolution		Input Resistance
		7½* Digits	6½ Digits	
100 mV	200.0000 mV	—	100 nV	$\geq 10,000 \text{ M}\Omega$
1V	2.000000V	—	1 $\mu\text{V}$	$\geq 10,000 \text{ M}\Omega$
10V	20.00000V	1 $\mu\text{V}$	10 $\mu\text{V}$	$\geq 10,000 \text{ M}\Omega$
100V	128.0000V	—	100 $\mu\text{V}$	10 $\text{M}\Omega$
1000V	1200.000V	—	1 mV	10 $\text{M}\Omega$

\*In AVG operating mode

Accuracy, Normal Mode, 6½ Digits:  $\pm(\%$  of Rdg + Counts)

Range	24 Hours* 23°C $\pm 1^\circ\text{C}$	Long Term, 18°C to 28°C	
		Up to 90 Days	Add per Month Over 90 Days
100 mV	0.0018 + 15	0.0025 + 40	0.00017 + 5.6
1V	0.0008 + 7	0.0015 + 8	0.0001 + 0.1
10V	0.0006 or 6**	0.0010 + 8	0.0001 + 0.1
100V	0.0010 + 6	0.0018 + 8	0.00013 + 0.1
1000V	0.0008 + 6	0.0018 + 8	0.00013 + 0.1

\*After 4-hour warm-up and within 1 hour of zeroing dc

\*\*Whichever is greater

Accuracy, AVG Mode, 6½ Digits:  $\pm(\%$  of Rdg + Counts)\*

Range	24 Hours* 23°C $\pm 1^\circ\text{C}$	Long Term, 18°C to 28°C	
		Up to 90 Days	Add per Month Over 90 Days
100 mV	0.0010 + 8	0.0020 + 8	0.0001 + 0.1
1V	0.0005 + 4	0.0012 + 6	0.0001 + 1
10V**	0.0005 or 50***	0.0008 + 60**	0.00008 + 1**
100V	0.0005 + 5	0.0015 + 6	0.0001 + 0.1
1000V	0.0005 + 5	0.0015 + 6	0.0001 + 0.1

\*After 4-hour warm-up and within 1 hour of zeroing dc

\*\*7½-digit mode of operation

\*\*\*Whichever is greater

## Accuracy, Software Calibration

Fully restores above "24-hour" accuracy for 24 hours each time performed within 30 days after hardware calibration is performed. After 30 days add the following number of counts to the 24-hour accuracy specifications.

Time Since Internal (Hardware) Calibration	Number of Counts to be Added	
	6½ Digits	7½ Digits
Less than 30 Days	0	0
30 to 90 Days	1	10
90 Days to 1 Year	2	20
More than 1 Year	3	30

Temperature Coefficient:  $\pm(\%$  of Rdg + Counts)/°C

Range	18°C to 0°C and 28°C to 50°C	
	6½ Digits	7½ Digits
100 mV	0.0003 + 5	0.0003 + 50
1V	0.0003 + 1	0.0003 + 10
10V	0.0002 + 0.5	0.0002 + 5
100V	0.0003 + 1	0.0003 + 10
1000V	0.0003 + 0.5	0.0003 + 5

## Input Bias Current

At time of Adjustment	1 Year 23°C $\pm 1^\circ\text{C}$	Temperature Coefficient
$< \pm 5 \text{ pA}$	$< \pm 30 \text{ pA}$	$< \pm 1 \text{ pA}/^\circ\text{C}$

**Zero Stability:** Less than 5  $\mu\text{V}$  for 90 days after a four hour warm-up. Front panel pushbutton zero is provided for permanent storage of a zero correction for each range. Zero may be turned off at any time.

## Normal Mode Rejection

Line Frequency	Filter Mode	4 Samples Per Reading	32 Samples Per Reading	128 Samples Per Reading
50 Hz	Fast	60 dB	70 dB	75 dB
50 Hz	Slow	85 dB	90 dB	95 dB
60 Hz	Fast	60 dB	70 dB	75 dB
60 Hz	Slow	90 dB	95 dB	100 dB



# DIGITAL MULTIMETERS

**8506A/8505A**

**Common Mode Rejection:** 160 dB at 60 Hz with 1 k $\Omega$  in series with either lead, and 4 samples or more per reading. Greater than or equal to 100 dB with less than 4 samples per reading.

## Analog Settling Time

Filter Mode	Filter Command	To 0.01% of Step Change	To 0.001% of Step Change
Bypassed	F1	2 ms	20 ms
Fast	F0 or F3	40 ms	50 ms
Slow	F or F2	400 ms	500 ms

**Digitizing Time (Line Synchronous):** For  $2^0$  to  $2^{17}$  samples per reading the digitizing time is from 4 ms to 9 minutes 6 seconds using a 60 Hz line. Time increases 20% using 50 Hz ac line. Selectable in 18 binary steps.

**Digitizing Time (Line Asynchronous):** 2 ms in 3-byte binary mode with dc zero, offset, limits and calibration factors turned off

**Maximum Input:**  $\pm 1200$  V dc or 1000 V rms ac to 60 Hz, or 1400 V peak above 60 Hz may be applied continuously to any dc range without permanent damage. Maximum rate of voltage change is 1000 V per  $\mu$ s.

## Ratio (External DC Reference)

Voltage, resistance, or current may be measured and compared to an external dc voltage and displayed as a ratio. Option -02A or -03 is required when measuring resistance or current. The dc reference voltage ( $V_{xref}$ ) is applied to terminals on the back panel and is the denominator of the ratio.

**Input Resistance:**  $>10,000$  M $\Omega$  between Ext Ref HI and LO and between either Ext Ref HI or LO and Ohms Guard or Sense LO

**Max. Reference Voltage:**  $\pm 40$  V between Ext Ref HI and LO terminals providing neither terminal is greater than  $\pm 20$  V relative to the Sense LO or Ohms Guard terminal

**Min. Reference Voltage:**  $\geq 0.0001$  V when comparing voltage or current, and  $\geq 0.0001$  V or 1 billionth of the absolute value of resistance, whichever is greater, when comparing resistance

**Maximum Ratio Display:**  $10^{-9}$  to  $10^9$

**Source Impedance:** Resistive unbalance (Ext Ref HI to LO)  $<4$  k $\Omega$ . Total resistance to Sense LO from either Ext Ref HI or LO  $<20$  k $\Omega$

**Overload Voltage:**  $\pm 180$  V dc or peak ac relative to Ohms Guard or Sense LO.  $\pm 360$  V dc or peak ac (Ext Ref HI to LO)

**Normal Mode Noise Rejection:**  $\geq 100$  dB for line frequency and 2x line frequency

**Common Mode Noise Rejection:**  $\geq 75$  dB for dc, line frequency, and 2x line frequency

## Ratio Accuracy

External Reference Voltage	Accuracy
$\pm 20$ V to $\pm 40$ V	$\pm(A + B + 0.001\%)$
$\pm V_{min}$ to $\pm 20$ V	$\pm(A + B + (0.02\% \div  V_{xref} ))$

A = 10 V dc range accuracy for the appropriate period of time

B = Input signal function and range accuracy for the appropriate period of time

$V_{min}$  = Minimum allowable external reference voltage

$|V_{xref}|$  = Absolute value of the external reference voltage

**Digitizing Time:** 196 ms to 9 minutes and 6s for  $2^0$  to  $2^{17}$  samples per reading using 60 Hz line, increasing 20% using 50 Hz line.

## AC Voltage (Thermal RMS)

All ac voltage accuracy and stability specifications for 5 $\frac{1}{2}$ -digit displays using at least 25% of full scale after a 2-hour warm-up. Except where noted, ac coupling is used to block dc. The 24-hour specifications are relative to the calibration standards used and within 1 hour of dc zero.

## Input Characteristics

Range	Full Scale (5 $\frac{1}{2}$ Digits)	Resolution		Input Impedance
		6 $\frac{1}{2}$ Digits*	5 $\frac{1}{2}$ Digits	
100 mV	125.000 mV	—	1 $\mu$ V	1 M $\Omega$ $\pm 1\%$ shunted by $<180$ pF
300 mV	400.000 mV	—	1 $\mu$ V	
1V	1.25000V	1 $\mu$ V	10 $\mu$ V	
3V	4.00000V	1 $\mu$ V	10 $\mu$ V	
10V	12.5000V	10 $\mu$ V	100 $\mu$ V	
30V	40.0000V	10 $\mu$ V	100 $\mu$ V	
100V	125.000V	100 $\mu$ V	1 mV	
500V	600.000V	100 $\mu$ V	1 mV	

\*In AVG operating mode

## Settling Time

**High Accuracy Mode:** Sample time is 3.5 seconds, hold time is 2.5 seconds. Measurement time is 6 seconds — the sum of sample time and hold time. If the state of the instrument is unknown, two complete measurement cycles will be required to guarantee a correct reading. Use of an external trigger will allow a 6-second measurement cycle.

**Enhanced Mode:** The first reading requires the same time as the high accuracy mode. Subsequent readings occur every 500 milliseconds. If the input changes 0.1% the analog settling time to 90-day mid-band accuracy is 1.5 seconds.

**Normal Mode:** Settling time for large changes is non-linear. Zero to full scale changes require 2.0 seconds to settle to 90-day, mid-band specifications. Full scale to 10% of full scale changes require 3.0 seconds to settle to mid-band, 90-day specifications. Small changes ( $<1\%$ ) settle to mid-band specifications in  $<1.5$  seconds.

**Autorange:** Upranges when input is higher than full scale. Downranges when reading is less than approximately 28% of full scale.

## Accuracy, High-Accuracy Mode: $\pm(\%$ of Reading)

24 Hours, 23°C  $\pm 1^\circ$ C

Ranges	Frequency in Hertz					
	10** to 40	40 to 20k	20k to 50k	50k to 100k	100k to 200k	200k to 500k
100 mV	0.08	0.02*	0.04*	0.2	0.6	1.5
300 mV to 10V	0.08	0.012	0.04	0.2	0.5	1.5
30V	0.08	0.012	0.05	0.2	0.5	3.5
100V	0.08	0.012	0.04	0.2	1.0	3.5
500V	0.08	0.012	0.04	0.2	—	—

90 Days, 18°C to 28°C

100 mV	0.08	0.026*	0.06	0.2	0.6	1.5	3.5
300 mV to 10V	0.08	0.016	0.06	0.2	0.5	1.5	3.5
30V	0.08	0.016	0.06	0.2	0.5	3.5	12
100V	0.08	0.016	0.06	0.2	1.0	3.5	—
500V	0.08	0.016	0.06	0.2	—	—	—

$>90$  Days, 18°C to 28°C, per month. Add to the 90-day specification the following % of reading.

All	0.008	0.0001	0.0025	0.012	0.021	0.06	0.11
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\*Add 5 digits (5  $\mu$ V) to the % of reading

\*\*With Slow filter



## DIGITAL MULTIMETERS

8506A/8505A

**Accuracy, Enhanced Mode:** Add the following (% of reading + number of digits) to the accuracy specifications of the high accuracy mode —

Ranges	Time Since First Reading	
	<5 Min	>5 and <30 Min
All except 500V	0 + 0	0.003 + 4
500V	0 + 0	0.003 + 6

**Accuracy, Normal Mode:** Add the following % of reading to the accuracy mode specification of the high accuracy mode —

Segment of Scale	24 Hour, 90 Day	>90 Day Add per Month
0.25 x to 1 x full scale	0.4	0.044
0.1 x to 0.25 x full scale	0.6	0.055

**Stability:** 40 Hz to 20 kHz, <1°C Temperature Change

Range	±[% of Rdg + Counts]*	
	24 Hours	90 Days
100 mV, 1V, 10V, 100V	0.0025 + 1	0.004 + 1
300 mV, 3V, 30V	0.0025 + 3	0.004 + 4
500V	0.0025 + 5	0.004 + 6

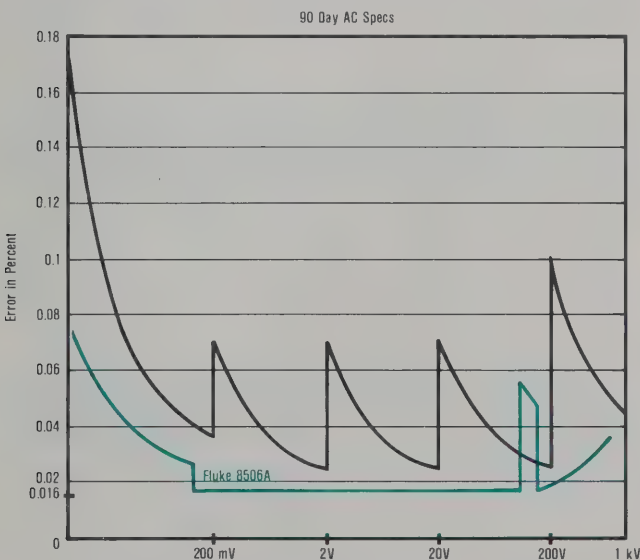
\*For 5½-digit resolution

**Crest Factor:** Up to 8:1, with 90-day or greater accuracy for input signals with peaks less than two times full scale and high frequency components within the 3 dB bandwidth. Up to 4:1 for signals with peaks less than four times full scale, with the addition of 0.03 to the percent-of-reading specification.

**3 dB Bandwidth (Typical):** 3 MHz for the 100 mV range and 10 MHz for the 300 mV, 1V, 3V and 10V ranges

**Maximum Input Voltage:** ±600V dc or rms ac, 840V peak, or 1x10<sup>7</sup> volt-hertz product

**DC-Coupled (AC+DC) Accuracy:** ±(1.1 times the appropriate ac-coupled specifications + a calculated "Adder" from the following table) —



This graph compares the total ac uncertainty of the 8506A's thermal rms converter to that of a typical computing rms converter used in other DMMs. The effects of floor error which cause large uncertainties at the beginning of each range are non-existent in the 8506A from 125 mV ac to 125V ac.

Range	Adder
100 mV to 1V	±(150 μV x (dc volts/total rms volts) )
3V and 10V	±(1 mV x (dc volts/total rms volts) )
30V and 100V	±(10 mV x (dc volts/total rms volts) )
500V	±(50 mV x (dc volts/total rms volts) )

**Temperature Coefficient:** One tenth of the 90-day accuracy specification per °C from 18°C to 0°C or 28°C to 50°C

**Common Mode Rejection:** >120 dB from dc to 60 Hz with 100Ω in series with either lead

## 8506A Option Specifications

## Resistance Option (-02A)

All resistance accuracy and stability specifications apply after a 2-hour warm-up. The 24-hour specifications are relative to the calibration standards used.

## Input Characteristics

Range	Full Scale (5½ Digits)	Resolution*		Current Through Unknown
		6½ Digits	5½ Digits	
10Ω	20.0000Ω	10 μΩ	100 μΩ	10 mA
100Ω	200.000Ω	100 μΩ		10 mA
1 kΩ	2.00000 kΩ	1 mΩ	6½ Digits	1 mA
10 kΩ	25.0000 kΩ	10 mΩ	Only	78 μA
100 kΩ	250.000 kΩ	100 mΩ		7.2 μA
1 MΩ	4.10000 MΩ	1Ω	10Ω	4.5 μA
10 MΩ	35.0000 MΩ	10Ω	100Ω	0.45 μA
100 MΩ	265.000 MΩ	100Ω	1 kΩ	56 nA

\* In normal operating mode, 5½ or 6½ digits depending on range. In AVG operating mode, 6½ digits on all ranges.

**Open Circuit Voltage:** 7V maximum from 10Ω through 100k range; 25V maximum from 1 MΩ range through 100 MΩ range

**Maximum Input:** ±400V dc or peak ac, continuous on any range with no damage

**Analog Settling Time:** 80 ms with Fast filter or 800 ms with Slow filter, to rated accuracy

**Digitizing Time:** Depending on sample rate and filter selection the digitizing time will vary from 145 ms to 9 minutes 6 seconds using a 60 Hz ac line. Time increases 20% using a 50 Hz line.

**Accuracy, 5½ Digits:** ±(% of Rdg + Counts)\*\*

Range	24 Hours 23°C ±1°C	Long Term, 18°C to 28°C		Plus Temp Coefficient Per °C*
		Up to 90 Days	>90 Days Add to % of Rdg	
10Ω	0.003+20	0.005+20	0.00056	0.0008+1.5
100Ω	0.002+1.4	0.003+1.4	0.00033	0.0007+0.2
1 kΩ	0.002+0.8	0.003+0.8	0.00033	0.0007+0.2
10 kΩ	0.002+0.8	0.003+0.8	0.00033	0.0007+0.2
100 kΩ	0.002+0.8	0.003+0.8	0.00033	0.0007+0.5
1 MΩ	0.002+0.8	0.003+0.8	0.00033	0.001+0.5
10 MΩ	0.0075+0.8	0.02+0.8	0.0022	0.005+0.5
100 MΩ	0.026+0.8	0.05+1	0.0056	0.02+0.5

\*From 18°C to 0°C or 28°C to 50°C

\*\*For 6½-digit display, multiply number of counts by 10

**Measurement Configuration:** Two-wire and four-wire available on all ranges

**Four-Wire Lead Resistance:** Source leads should not exceed 10Ω for the 10Ω and 100Ω ranges, 100Ω for the 1 kΩ range, or 1 kΩ for the 10 kΩ or higher ranges



# DIGITAL MULTIMETERS

## 8506A/8505A

### DC Current Option (-03)

All current accuracy and stability specifications apply after a 2-hour warm-up. The 24-hour specifications are relative to the calibration standards used. No ac current option is available for the 8506A.

### Input Characteristics

Range	Full Scale (5½ Digits)	Resolution		Voltage Burden
		6½* Digits	5½ Digits	
100 µA	250.000 µA	0.1 nA	1 nA	≤100 mV
1 mA	2.00000 mA	1 nA	10 nA	≤100 mV
10 mA	16.0000 mA	10 nA	100 nA	≤200 mV
100 mA	128.000 mA	100 nA	1 µA	≤200 mV
1 A	1.28000 A	1 µA	10 µA	≤500 mV

\*In AVG operating mode

### Accuracy, 5½ Digits: ±(% of Rdg + Counts)\*\*

Range	24 Hours 23°C ±1°C	Long Term, 18°C to 28°C		Plus Temp Coefficient Per °C*
		Up to 90 Days	>90 Days Add to % of Rdg	
100 µA	0.02+10	0.03+10	0.0022	0.0025+0.6
1 µA	0.02+10	0.03+10	0.0022	0.0025+0.6
10 mA	0.02+10	0.03+10	0.0022	0.0025+0.6
100 µA	0.03+20	0.05+20	0.0056	0.0035+0.6
1 A	0.03+20	0.05+20	0.0056	0.0035+0.6

\*From 18°C to 0°C or 28°C to 50°C

\*\*For 6½-digit display, multiply number of counts by 10

**Overload:** 1.5A maximum, ±140V dc or peak ac to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage. Protected by a 1.5A fuse.

**Settling and Digitizing Time:** Same as for dc volts

### IEEE-488 Interface Option (-05)

This interface incorporates the following subset of the IEEE Standard 488-1978; SH1, AH1, T5, L4, SR1, RL2, DC1, DT1, and E1. The interface allows full control of all instrument functions and the transfer of ASCII or binary data. In the binary mode the instrument is capable of 500 readings per second.

### RS-232 Interface Option (-06)

This interface is a bit serial asynchronous interface providing either voltage or 20 mA current loop level signals. The interface allows selection of baud rate from 50 to 9600, either one or two stop bits, and odd or even parity. Up to 40 ASCII character readings per second are possible with Option -06.

### Bit-Parallel Interface Options (-07A, -07B, -07D, -07H, -07L)

Permit you to connect the instrument to a large variety of minicomputer and microcomputer interfaces. This is accomplished via a plug-in header called a "personality card" that you may wire to your system or that may be supplied in standard versions by Fluke. Personality cards are available for three DEC PDP 11 interfaces (DRIIC, DRVII and PC11) and for two HP interfaces (HP 12566 and HP 98032A). The interface permits either 8- or 16-bit parallel ASCII transfers or 8- or 16-bit parallel binary transfers. In the binary mode the instrument is capable of up to 500 readings per second.

## 8505A Specifications

### DC Voltage

Same specifications as for 8506A

### Ratio (External DC Reference)

Same specifications as for 8506A for dc ratio. AC/AC ratio available upon special request

## 8505A Option Specifications

### True-RMS AC Voltage Option (-09A)

All true-rms ac voltage accuracy and stability specifications apply to readings between 0.1% of range to full scale after a 2-hour warm-up. Options -09A and -01 may not be installed at the same time.

### Accuracy: ±(% of Rdg + % of Full Scale)\*

Frequency	90 Days, 18°C to 28°C		
	% of Rdg	% Full Scale	
		(AC)	(AC + DC)
DC	0.1	—	0.03
10 Hz to 20 Hz	1.0	0.04	0.06
20 Hz to 50 Hz	0.5	0.012	0.03
50 Hz to 10 kHz	0.1	0.012	0.03
10 kHz to 30 kHz	0.2	0.04	0.06
30 kHz to 50 kHz	0.3	0.1	0.12
50 kHz to 100 kHz	1.0	0.3	0.3
100 kHz to 300 kHz	2.0	0.5	0.5
300 kHz to 1 MHz	3.3	1.8	1.8

\* Slow filter must be used below 400 Hz. For inputs greater than 500V multiply the accuracy specification by:  $(2000 + \text{reading}) \div 2000$

**Common Mode Rejection:** >120 dB, dc to 60 Hz, with 100Ω unbalance in either lead

**Crest Factor:** >7 at full scale, increasing down scale by

$$7x \sqrt{V_{\text{Range}} \div V_{\text{Reading}}}$$

**Voltage & Frequency Limits:**  $1x10^7$  volt-hertz product for the 1V and 10V ranges and  $2x10^7$  for the 100V and 1000V ranges

**Analog Settling Time:** 100 ms with Fast filter and 500 ms with Slow filter to within 0.1% of a step change within a range

**Digitizing Time:** Same as for dc voltages. See 8506A specifications

### Average-Sensing AC Voltage Option (-01)

All average-sensing ac voltage accuracy and stability specifications apply to a 5½-digit display with readings between 0.1% of range to full scale after a 2-hour warm-up. Option -01 and -09A may not be installed at the same time.

### Input Characteristics

Range	Full Scale (5½ Digits)	Resolution		Input Impedance
		6½* Digits	5½ Digits	
1V	2.50000	1 µV	10 µV	1 MΩ
10V	20.0000	10 µV	100 µV	shunted
100V	160.000	100 µV	1 mV	by
1000V	1000.00	1 mV	10 mV	<100 pF

\*In AVG operating mode

### Accuracy: ±(% of Rdg + Counts)\*

Frequency	90 Days, 18°C to 28°C	
	0 to 500V**	Above 500V
30 Hz to 50 Hz	0.5 + 5	0.55 + 5
50 Hz to 10 kHz	0.05 + 5	0.1 + 5
10 kHz to 40 kHz	0.1 + 5	0.15 + 5
10 kHz to 50 kHz**	0.1 + 5	—
50 kHz to 100 kHz**	0.5 + 5	—

\* Slow filter must be used below 400 Hz. For 6½-digit display, multiply number of counts by 10

\*\* On 1-volt range add 7 counts above 10 kHz or 35 counts above 50 kHz

**Common Mode Rejection:** >120 dB, dc to 60 Hz with 100Ω imbalance in either lead

**Voltage and Frequency Limits:** 1000V rms (1400V peak) or  $2x10^7$  volt-hertz product, whichever is less

**Analog Settling Time:** 100 ms with Fast filter and 500 ms with Slow filter, to within 0.05% of step change within a range

**Digitizing Time:** Same as for dc voltages. See 8506A specifications



## DIGITAL MULTIMETERS

8506A/8505A

**Resistance Option (-02A)**

Same specifications as for 8506A

**DC and AC Current Option (-03)**

All accuracy and stability specifications apply after a 2-hour warm-up.

**Input Characteristics:** Same as for 8506A**DC Current Accuracy:** Same as for 8506A**AC Current Accuracy:**  $\pm(\% \text{ of Rdg} + \text{Counts})^*$ 

Range	Frequency	90 Days, 23°C $\pm 5^\circ\text{C}$	
		Option -01	Option -09A
100 $\mu\text{A}$	10-20 Hz	—	1.0 + 110
	20-50 Hz	0.8 + 9	0.8 + 35
	50 Hz-10 kHz	0.4 + 9	0.4 + 35
	10-20 kHz	0.7 + 9	1.0 + 110
	20-50 kHz	1.5 + 9	1.5 + 260
	50-100 kHz	3.0 + 9	4.0 + 760
1 mA and 10 mA	10-20 Hz	—	1.0 + 110
	20-50 Hz	0.5 + 9	0.5 + 35
	50 Hz-10 kHz	0.06 + 9	0.11 + 35
	10-20 kHz	0.11 + 9	0.2 + 110
	20-50 kHz	0.12 + 9	0.3 + 260
	50-100 kHz	0.51 + 9	1.0 + 760
100 mA	10-20 Hz	—	1.0 + 150
	20-50 Hz	0.5 + 55	0.5 + 80
	50 Hz-10 kHz	—	0.26 + 80
	50 Hz-100 kHz	0.24 + 55	—
1A	10-20 Hz	—	1.0 + 160
	20-50 Hz	0.5 + 65	0.5 + 90
	50 Hz-10 kHz	0.24 + 65	0.26 + 90

\* With 5½ digit display. For 6½-digit display, multiply number of counts by 10. AC Voltage Option -01 or -09A must also be installed to measure ac current

**Crest Factor:** (Using Option -09A) >4.5 at full scale, increasing down scale by

$$4.5 \times \sqrt{I_{\text{Range}} \div I_{\text{Reading}}}$$

**Maximum Overload:** 1.5A maximum,  $\pm 140\text{V}$  dc or peak ac to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage. Protected by a 1.5A fuse

**Settling and Digitizing Time:** Same as dc volts

**IEEE-488 Interface Option (-05)**

Same specifications as for 8506A

**RS-232 Interface Option (-06)**

Same specifications as for 8506A

**Bit-Parallel Interface Option (-07)**

Same specifications as for 8506A

**General Specifications, 8506A & 8505A****Maximum Terminal Voltage:**

LO to Guard, 127V rms

Guard to Chassis, 500V rms

HI Sense to HI Source, 127V rms

LO Sense to LO Source, 127V rms

HI Sense to LO Sense, 1000V rms or 1200V dc

HI Source to LO Source, 280V rms

**Trigger Input:** TTL level,  $\pm 30\text{V}$  maximum, factory wired for falling edge; may be rewired for rising edge. Pulse width  $\geq 10 \mu\text{s}$

**Scanner Advance Pulse:** TTL level,  $\geq 3 \mu\text{s}$  width

**Shock & Vibration:** Meets requirements of MIL-T-28800C for Type III, Class 5, Style E equipment

**Temperature:** 0°C to 50°C, operating; -40°C to 70°C, non-operating

**Relative Humidity:**  $\leq 80\%$  0°C to 18°C,  $\leq 75\%$  to 40°C,  $\leq 45\%$  to 50°C

**Size:** 10.8 cm H x 43.2 cm W x 42.5 cm D (4.25 in x 17 in x 16.75 in)

**Weight:** 10 kg (22 lb) basic, 12 kg (26 lb) fully loaded

**Included:** Manual, power cord, serialized and dated calibration certification sheet

**Models**

January 1985 prices

8506A Thermal RMS Digital Multimeter .....	\$5845
8505A Digital Multimeter .....	3195

**Options for 8506A & 8505A\*\***

8505A-02A* Ohms Converter .....	475
8500A-03* Current Converter .....	475
8500A-05 IEEE-488 Interface .....	495
8500A-06 RS-232-C Interface .....	495
8500A-07A Parallel Interface (for DEC PDP11, DR11C or DRVII) .....	495
8500A-07B Parallel Interface (for DEC PDP11, PC11) .....	495
8500A-07D Parallel Interface (general purpose) .....	495
8500A-07H Parallel Interface (for HP12566 or 98032A) .....	495
8500A-07L Parallel Interface, low noise (for DEC PDP11, DR11C, or DRVII) .....	495

\* Cannot install both -02A and -03 in 8506A at the same time

\*\*All options are customer installable

**Options for 8505A only**

8500A-01* AC Converter (Average) .....	575
8500A-09A* AC Converter (True-RMS) .....	625

\* Cannot install both -01 and -09A in 8505A at the same time

**Accessories (Also see page 55)**

M00-260-610 18" Rack Slide Kit (rack adapter req'd) .....	105
M00-280-610 24" Rack Slide Kit (rack adapter req'd) .....	110
M04-205-600 5¼" Rack Adapter .....	95
Y8021 1m, IEEE-488 Shielded Cable .....	85
Y8022 2m, IEEE-488 Shielded Cable .....	95
Y8023 4m, IEEE-488 Shielded Cable .....	105
Y8133 Universal Test Leads .....	20
Y8140 Slim Test Leads .....	18
Y8077 Four Terminal Short .....	30

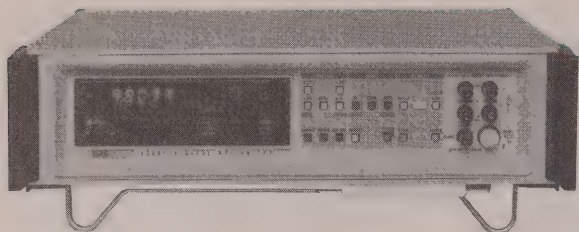
**After-Warranty Service (See page 227)**

SC1-8506A, per 90-day interval .....	456
SC1-8505A, per 90-day interval .....	344

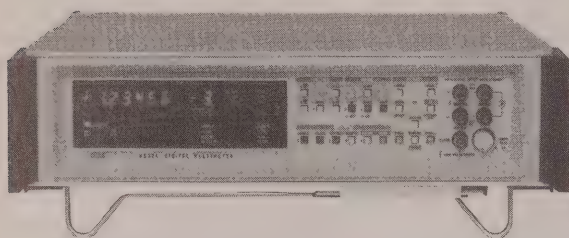


# DIGITAL MULTIMETERS

## 8500A/8502A



8500A



8502A

### 8500A/8502A Digital Multimeters

- 6 ppm dc accuracy
- 6½-digit resolution
- 500 readings per second system speed
- Modular construction for configurability
- Interface options:  
IEEE-488, RS-232-C, or Parallel
- Measurement options:  
AC volts, true-rms or averaging  
Resistance  
Current
- Up to 212% overrange

The 8500A and 8502A Digital Multimeters are very similar. When used in a system under the control of a computer or an instrument controller, the performance of the 8500A and 8502A are practically identical. But the 8500A is primarily for use in a system so does not have as many front panel controls as the 8502A. For example, you can't enter digits from the front panel to be stored and used as a scaling factor, limit, etc. With the 8502A, every measurement that may be controlled remotely may also be controlled from the front panel, making the 8502A as capable on the bench as in a system.

### Circuit Card Modules

The basic 8500A and 8502A measures dc voltage or the ratio of two dc voltages. With optional plug-in circuit card modules it will also measure resistance, ac or dc current, ac voltage, or the ratio of such a quantity to an external dc voltage.

One option is for resistance, one is for current, and two are for ac voltage — either true-rms for sinusoidal or non-sinusoidal waveforms, or average-sensing for sinewaves. The current-measuring option is good for both dc and ac current but one of the ac voltage measurements options must also be installed. All the measurement capabilities may be included in one instrument if you wish, except that only the true-rms or the average-sensing measurement module can be included at one time.

### Peaks, Valleys, Limits, Calculations

The 8500A or 8502A may be operated to store the highest and the lowest values in series of measurements for determining deviations, either directly or as a percentage. Or, where measurements are for testing whether certain values are within acceptable limits, preset limits may be entered and stored for comparison. Then, measurements within limits are classified simply as PASS. Measurements that fall outside of limits are classified as either HI or LO, depending on whether they exceed a high limit or fall below a low limit. These classifications appear in the display whether it is operated remotely or operated from the front panel.

Measured values may be multiplied by a factor before a numerical value is displayed. Or, using offset, both multiplied and added (or subtracted) using the general formula:  $Y = mx + b$ .

### Triggered Measurements & Interfaces

Each measurement may be initiated externally with a simple trigger signal. Although triggering is primarily for systems applications which also require one of three interface options (-05, -06, or -07), it is also useful for less automated applications. The trigger signal may be derived from TTL circuits or any source that delivers a nominal 0 to +5 transition, a foot switch, for example.

### Specifications

#### DC Volts

Range	Normal Full Scale	Resolution	Resistance
100 mV	312 mV	1 $\mu$ V	>10,000 M $\Omega$
1V	2.5V	10 $\mu$ V	>10,000 M $\Omega$
10V	20V	100 $\mu$ V	>10,000 M $\Omega$
100V	160V	1 mV	10 M $\Omega$
1000V	1200V	10 mV	10 M $\Omega$

#### Reading Rate (Bench Operation)

Fast: 7½ rdgs/s (60 Hz line); 6¼ rdgs/s (50 Hz line)

Slow: 1-7/8 rdgs/s (60 Hz line); 1½ rdgs/s (50 Hz line)

#### Accuracy, 6½-Digit: $\pm$ (% of Rdg + Counts)

Range	24 Hours 23°C $\pm$ 1°C	90 Days 18°C to 28°C	1 Year 18°C to 28°C	Plus Temp Coefficient per °C <sup>2</sup>
100 mV <sup>1</sup>	0.002+4	0.003+5	0.005+8	0.0003+0.5
1V	0.001+6	0.002+8	0.004+9	0.0003+0.1
10V	0.0006 or 6*	0.001+8	0.002+9	0.0002+0.5
100V	0.001+6	0.002+8	0.004+9	0.0003+1
1000V	0.001+6	0.002+8	0.004+9	0.0003+0.5

\* Whichever is greater

<sup>1</sup> 5½-digit accuracy on lowest range

<sup>2</sup> 18°C to 0°C and 28°C to 50°C

#### Normal Mode Noise Rejection

Filter	Programmed 4 Samples/rdg	50 Hz 1-1/2 rdgs/s	60 Hz 1-7/8 rdgs/s
50 Hz, Fast	60 dB	75 dB	—
50 Hz, Slow	85 dB	95 dB	—
60 Hz, Fast	60 dB	—	—
60 Hz, Slow	90 dB	—	100 dB

**Common Mode Rejection:** 100 dB at 60 Hz with 1 k $\Omega$  unbalance

**Overload:**  $\pm$ 1200V dc or 1400V pk ac, may be applied continuously to any range without permanent damage

**Common Mode Noise Rejection:**  $\geq$ 120 dB, dc to 60 Hz, with 100 $\Omega$  unbalance



## DIGITAL MULTIMETERS

8500A/8502A

**Ratio**

Measurements of dc or ac voltage, dc or ac current, or resistance is divided by the measurement of an externally applied dc voltage and displayed as a ratio. The measurements are made on two separate isolated sets of terminals but there should be no more than 20,000 ohms between the Sense LO terminal and either the HI or LO Reference input terminal. Input characteristics of the Sense terminals depend on the function selected. Characteristics of the rear panel Ext Ref input are as follows:

**Input Resistance:** >10,000 M $\Omega$

**Max Reference Voltage:** 40V dc between Ext Ref HI and LO terminals, providing neither terminal is greater than  $\pm 20V$  relative to the Sense LO or Ohms Guard terminal

**Minimum Ext Reference Voltage:** Equal to the input (voltage, current, or resistance) divided by 10X the range selected or 100  $\mu V$ , whichever is greater

**Ratio reading:** <10 times the value of the volts, amps, or ohms range selected

**Normal Mode Noise Rejection:**  $\geq 100$  dB for dc and 1X and 2X-line frequency

**Common Mode Noise Rejection:**  $\geq 75$  dB for 1X and 2X line frequency

**Overload:**  $\pm 180V$  peak, 127V rms relative to Sense LO terminal or Ohms Guard terminal

**Accuracy:** For reference voltages of 20V to 40V, accuracy is  $\pm(A + B + 10 \text{ ppm})$ , where A = 10V dc-range accuracy and B = input voltage-, current-, or resistance-range accuracy. For reference voltages less than 20V, accuracy is

$$\pm(A + B + 200 \text{ ppm}) \div V_{\text{ref}}$$

**Option Specifications****True-RMS AC Volts Option (-09A)**

Range	Full Scale	Normal Resolution	Impedance
1V	2.5V	10 $\mu V$	1 M $\Omega$ , <100 pF
10V	20V	100 $\mu V$	
100V	160V	1 mV	
1000V	1000V	10 mV	

**Accuracy:**  $\pm(\% \text{ of Rdg} + \% \text{ of Full Scale})$

Frequency	90 Days, 18°C to 28°C		
	% of Input	+% FS (AC)	+% FS (AC + DC)
DC	0.1	—	0.03
10 Hz to 20 Hz	1.0	0.04	0.06
20 Hz to 50 Hz	0.5	0.012	0.03
50 Hz to 10 kHz	0.1	0.012	0.03
10 kHz to 30 kHz	0.2	0.04	0.06
30 kHz to 50 kHz	0.3	0.1	0.12
50 kHz to 100 kHz	1.0	0.3	0.3
100 kHz to 300 kHz	2.0	0.5	0.5
300 kHz to 1 MHz	3.3	1.8	1.8

1. Filter must be used for full accuracy below 400 Hz
2. Volt-Hertz product not to exceed  $2 \times 10^7$ ; 300 kHz to 1 MHz, not to exceed  $1 \times 10^7$
3. For inputs above 500V, multiply accuracy by  $(2000V + V_{\text{in}}) \div 2000V$

**Common Mode Noise Rejection:**  $\geq 120$  dB, dc to 60 Hz, with 100 $\Omega$  unbalance

**Crest Factor:** >7 at full scale, increasing down scale by:

$$7 \sqrt{V \text{ Range} \div V \text{ Input}}$$

**Average-Sensing AC Volts Option (-01)**

Range	Full Scale	Normal Resolution	Impedance
1V	2.5V	10 $\mu V$	1 M $\Omega$ , <100 pF
10V	20V	100 $\mu V$	
100V	160V	1 mV	
1000V	1000V	10 mV	

**Accuracy:**  $\pm(\% \text{ of Rdg} + \text{Counts})^*$

Frequency	90 Days, 18°C to 28°C	
	0 to 500V**	Above 500V
30 Hz to 50 Hz	0.5 + 5	0.55 + 5
50 Hz to 10 kHz	0.05 + 5	0.1 + 5
10 kHz to 40 kHz	0.1 + 5	0.15 + 5
10 kHz to 50 kHz**	0.1 + 5	—
50 kHz to 100 kHz**	0.5 + 5	—

\*Slow filter must be used below 400 Hz. For 6 1/2-digit display, multiply number of counts by 10

\*\*On 1-volt range add 7 counts above 10 kHz or 35 counts above 50 kHz

**Common Mode Noise Rejection:**  $\geq 120$  dB, dc to 60 Hz, with 100 $\Omega$  unbalance

**Resistance Option (-02)**

Range	Full Scale	Normal Resolution	Current Through Unknown
10 $\Omega$	31.25 $\Omega$	100 $\mu \Omega$	10 mA
100 $\Omega$	250 $\Omega$	1 m $\Omega$	10 mA
1 k $\Omega$	2 k $\Omega$	10 m $\Omega$	1.25 mA
10 k $\Omega$	32 k $\Omega$	100 m $\Omega$	78 $\mu A$
100 k $\Omega$	256 k $\Omega$	1 $\Omega$	9.8 $\mu A$
1 M $\Omega$	4.096 M $\Omega$	10 $\Omega$	4.9 $\mu A$
10 M $\Omega$	32.768 M $\Omega$	100 $\Omega$	0.61 $\mu A$
100 M $\Omega$	262.144 M $\Omega$	1 k $\Omega$	76 nA

**Accuracy:**  $\pm(\% \text{ of Rdg} + \text{Counts})$

Range	24 Hours 23°C $\pm 1^\circ C$	90 Days 18°C to 28°C	1 Year 18°C to 28°C
10 $\Omega$	0.003 + 20	0.005 + 20	0.01 + 20
100 $\Omega$	0.002 + 2	0.003 + 2	0.006 + 2
1 k $\Omega$	0.002 + 1	0.003 + 1	0.006 + 1
10 k $\Omega$	0.002 + 1	0.003 + 1	0.006 + 1
100 k $\Omega$	0.002 + 1	0.003 + 1	0.006 + 1
1 M $\Omega$	0.002 + 1	0.003 + 1	0.006 + 1
10 M $\Omega$	0.01 + 1	0.02 + 1	0.04 + 1
100 M $\Omega$	0.03 + 1	0.05 + 1	0.1 + 1

**Open Circuit Voltage**

Range	Voltage	Configuration
10 $\Omega$ to 100 $\Omega$	7V max	4-terminal
100 k $\Omega$ to 100 M $\Omega$	25V max	2-terminal

**Overload:**  $\pm 400V$  dc to 60 Hz, or 560V peak above 60 Hz max, continuous on any range with no damage

**Reading Rate (Bench Operation)**

Filter	Approximate rdgs per second			
	60 Hz		50 Hz	
	Fast	Slow	Fast	Slow
Fast	4	1-1/2	3-1/3	1-1/4
Slow	1-1/4	5/6	1	3/4



# DIGITAL MULTIMETERS

## 8500A/8502A

### Current Option (-03)

Range	Full Scale	Resolution	Voltage Burden
100 $\mu$ A	312 $\mu$ A	1 nA	<100 mV
1 mA	2.5 mA	10 nA	<100 mV
10 mA	20 mA	100 nA	<200 mV
100 mA	160 mA	1 $\mu$ A	<200 mV
1 A	1.28A	10 $\mu$ A	<500 mV

**Overload:** Fused at 1.5A,  $\pm$ 140V ac or peak ac to 60 Hz, 200V peak ac above 60 Hz with no damage

**Settling and Digitizing Time:** Same as dc volts

### Direct Current Accuracy: $\pm$ (% of Input + Digits)

Ranges	24 Hours 23°C $\pm$ 1°C	90 Days 18°C to 28°C	1 Year 18°C to 28°C
100 $\mu$ A	0.02 + 10	0.03 + 10	0.05 + 10
1 mA	0.02 + 10	0.03 + 10	0.05 + 10
10 mA	0.02 + 10	0.03 + 10	0.05 + 10
100 mA	0.03 + 20	0.05 + 20	0.1 + 20
1 A	0.03 + 20	0.05 + 20	0.1 + 20

### Alternating Current Accuracy: $\pm$ (% of Rdg + Counts)\*

Range	Frequency	90 Days, 18°C to 28°C	
		Avg-Res Current	True RMS Current
100 $\mu$ A	10 Hz - 20 Hz	—	1.0 + 110
	20 Hz - 50 Hz	0.8 + 9	0.8 + 35
	50 Hz - 10 kHz	0.4 + 9	0.4 + 35
	10 kHz - 20 kHz	0.7 + 9	1.0 + 110
	20 kHz - 50 kHz	1.5 + 9	1.5 + 260
	50 kHz - 100 kHz	3.0 + 9	4.0 + 760
1 mA and 10 mA	10 Hz - 20 Hz	—	1.0 + 110
	20 Hz - 50 Hz	0.5 + 9	0.5 + 35
	50 Hz - 10 kHz	0.06 + 9	0.11 + 35
	10 kHz - 20 kHz	0.11 + 9	0.2 + 110
	20 kHz - 50 kHz	0.12 + 9	0.3 + 260
	50 kHz - 100 kHz	0.51 + 9	1.0 + 760
100 mA	10 Hz - 20 Hz	—	1.0 + 150
	20 Hz - 50 Hz	0.5 + 55	0.5 + 80
	50 Hz - 10 kHz	—	0.26 + 80
	50 Hz - 100 kHz	0.24 + 55	—
1 A	10 Hz - 20 Hz	—	1.0 + 160
	20 Hz - 50 Hz	0.5 + 65	0.5 + 90
	50 Hz - 10 kHz	0.24 + 65	0.26 + 90

\*Applies from 0.1% of full scale to full scale

**Crest Factor (True-RMS):**  $\geq 4.5$  at full scale, increasing down scale by  $4.5 \sqrt{\text{range} \div \text{input}}$

### Calibration Memory Option (-04)

Allows correction factor to be entered and stored for any or all ranges of any or all measurement functions, quickly and conveniently. Prevents downtime in calibration laboratory.

**Control:** Via front panel pushbuttons

**Storage Time:** 1 year if not used. Up to five years if used

**Calibration Points:** Decade value for each range

### IEEE Interface Option (-05)

The IEEE interface provides I/O compatibility per IEEE Std 488-1978. Order 1m, 2m, or 4m cable separately (Y8021, Y8022, Y8023)

### RS-232 Interface Option (-06)

This bit serial asynchronous interface option provides either voltage loop (EIA Standard RS-232-B or -C) or current loop (20 mA for Teletype) for interfacing to such things as computers, CRT displays, DEC writers, Teletypes, etc. Eight baud rates are available from 110 to 9600 and either one or two stop bits can be set up. Selection is made via rear panel logic switches.

### Parallel Interface Options (-07A,-07B,-07D,-07H,-07L)

These 16-bit parallel, character-serial interface options allow the 8500A or 8502A to interface to several mini-computers at a full 500 readings/second. Can be used for interfacing to 8-bit multiplex microcomputers or controllers. Both ASCII and binary (2's complement) coding are selected via command codes.

### General Specifications

**Temperature:** 0°C to 50°C, operating; -40°C to 70°C, non-operating

**Overload:** LO to guard is 100V max; guard to chassis is 1000V max

**Operating Power:** <50W with all options

**Warmup:** 1 hr to rated accuracy

**Dimensions:** 10.8 cm H x 42.5 cm L x 43.2 cm W (4.25 in H x 16.75 in L x 17 in W)

**Weight:** Basic is 9.1 kg (20 lb). All options are 11.3 kg (25 lb)

**Included:** Manual, power cord and Option -08 (8500A) or Option -08A (8502A). Order Y8133, or Y8140 test leads separately. Serialized and dated calibration certification sheet

### Models

January 1985 prices

8500A DMM	.....	\$4095
8502A DMM	.....	4295

### Options for 8500A and 8502A\*\*\*

8500A-01 Average Converter	.....	575
8500A-02 Ohms Converter	.....	700
8500A-03 Current Converter	.....	475
8500A-04 Cal Memory	.....	450
8500A-05 IEEE-488 Interface	.....	495
8500A-06 RS-232-C Interface	.....	495
8500A-07A Parallel Interface (for DEC PDP11, DRIIC or DRVII)	..	495
8500A-07B Parallel Interface (for DEC PDP11, PC11)	.....	495
8500A-07D Parallel Interface, general purpose	.....	495
8500A-07H Parallel Interface (for HP12566 or 98032A)	.....	495
8500A-07L Parallel Interface, low noise (for DEC PDP11, DRIIC, or DRVII)	.....	495
8500A-08* Interface Isolator	.....	225
8502A-08A* Interface Isolator	.....	225
8500A-09A RMS Converter	.....	625
8502A-16* Switchable Front/Rear Inputs	.....	475
8500A-17 Parallel Front/Rear Inputs	.....	200

\* Required when using any interface option. Option -08 now included with 8500A. Option -08A now included with 8502A.

\*\* For 8502A only

\*\*\* All options except -16 are customer installable

### Accessories (Also see page 55)

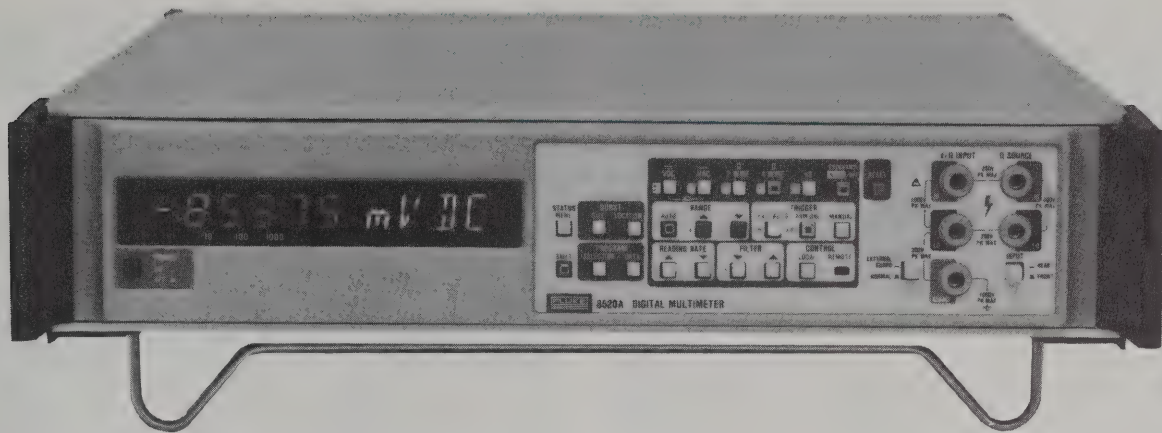
MIS-7011K Extender Card	.....	135
MIS-7013K Bus Interconnect and Monitor	.....	45
MIS-7190K Static Test Controller	.....	285
MIS-7191K Test Module	.....	475
M00-260-610 18" Rack Slide Kit (rack adapter req'd)	.....	105
M04-205-600 5/4" Rack Adapter	.....	95
Y8021 1m, IEEE-488 Shielded Cable	.....	85
Y8022 2m, IEEE-488 Shielded Cable	.....	95
Y8023 4m, IEEE-488 Shielded Cable	.....	105
Y8133 Universal Test Leads	.....	20
Y8140 Slim Test Leads	.....	18

### After-Warranty Service (See page 227)

SC1-8500A, per 90-day interval	.....	456
SC1-8502A, per 90-day interval	.....	456



## 8520A/AS & 8520A/PRT & 8520A & 8522A



8520A

## Intelligent DMMs for Bench or System

- DC and ac volts
- 2 and 4-wire ohms
- Conductance
- 520 readings per second
- 20 ppm basic dc accuracy
- Burst memory and math capabilities
- Standard system interfaces
- 8520A IEEE-488
- 8522A: Parallel and BCD
- New 8520A/AS MATE certified DMM

The 8520A and 8522A are designed for system and bench applications and have built-in system interface circuits. The performance specifications of the two instruments are almost identical. The principal difference is that the 8520A has an interface compatible with IEEE Std 488-1978 and the 8522A has an interface suitable for either BCD or Parallel (binary) applications.

The 8520A/AS and the 8520A/PRT are unique variations of the 8520A. One, the 8520A/AS, is compatible with U.S. Government Modular Automatic Test Equipment (MATE) system. And the 8520A/PRT includes a Platinum Resistance Probe for extremely accurate temperature measurements.

Seven standard and seven optional math programs plus a built-in "burst" memory make these multimeters exceptionally intelligent stand-alone units. A choice of dc volts, true-rms ac volts, 2-wire or 4-wire ohms, and the Fluke exclusive conductance function make the instruments very versatile. The conductance function provides a simple way to measure resistance from 10 MΩ to 100,000 MΩ.

The instruments boast 50 ppm basic dc accuracy for 90 days with 1/2-digit resolution. A 520 readings-per-second system rate with 1/2-digits resolution is standard for high speed measurements. Or make 240 readings per second (with 60 Hz line operation) with 1/2-digits resolution. Inputs are switchable from front to rear too.

An unprecedented degree of prompting and operational cues are provided for skilled and unskilled technicians alike. A simple, uncluttered color-coded front panel makes operation easy.

## Math Programs

Fourteen pre-programmed functions are available for the 8520A, 8520A/AS, 8520A/PRT, and 8522A. The first seven are standard; eight through fourteen are also standard on the 8520A/AS and 8522A but optional on the other models. For systems use, these powerful programs will reduce software overhead greatly. They also simplify

and speed testing for ordinary bench applications. Up to three math programs can be chained or stacked for simultaneous use.

## The standard programs

**I = TEST.** Four separate internal test programs do diagnostic checks on analog circuitry, digital hardware and software, and the front panel keys and displays.

**2 = ZERO.** Eliminates the effect of lead resistance for ohms tests and subtracts low-level dc components in the dc voltage function.

**3 = XREF** (external reference). Compares an unknown voltage at the front panel to a known rear-panel input. The display is the ratio of the front and rear inputs.

**4 = OSR (offset/scale/ratio).** Allows you to enter any constant in the formula ( $X = \text{measurement} \text{ minus offset times scale divided by ratio}$ ) from the keyboard, the memory, or a current reading.

**5 Δ PCT** (percent deviation). Compares all subsequent readings with a stored nominal value. The display appears as plus or minus a percentage deviation.

**6 = PEAK.** Constantly monitors the maximum and minimum readings. These values can be recalled as well as the "peak-to-peak" variation.

**7 = LIM (limits).** Turns the multimeter into a sorting machine. Inputs are sorted and displayed in three ways — “High,” “Pass” and “Low,” based on previously stored upper and lower limits. You can recall the number of high, low, and pass readings, plus the total number of readings.

**The other programs (part of Option -010) Standard in 8520A/AS & 8522A**

**8 = STAT** (statistics). Computes the mean, standard deviation, and variance of readings taken or data stored in memory registers.

**9 = LFAC.** A unique way to accurately measure low frequency ac signals from dc to 10 hertz.

**10 = dB.** Calculates dB, dBm or dBV of a measured value and displays dB.

11 = RTD. Implements equations which convert the resistance of a resistance temperature detector (RTD) to temperature in °C. Readouts in K or °F are also selectable.

**12 = JVC** (junction voltage Celsius). Computes °C, °F, or K based on inputs from a Fluke 80T-150C Temperature Probe (calibrated for °C).

13 = JVF (junction voltage Fahrenheit). For use with the Fluke 80T-150F (calibrated for °F). Performs the same operations as Program 12

**14 = THMS** (thermistor linearization). Converts the resistance of a thermistor to temperature in °C, °F, or K.

### Burst Memory (Reading Storage)

The unique burst memory lets you store up to 50 readings at any reading rate (400 readings with Option -010). In fact, the most recent 50 (or 400) readings are always stored in a shift register and available for recall and analysis whenever measurements cease. In the burst mode the storage operation may be independently triggered to capture a particular group of successive readings that may occur



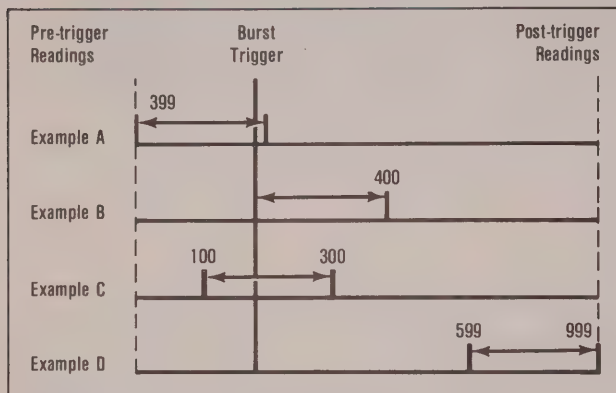
# DIGITAL MULTIMETERS

## 8520A/AS & 8520A/PRT & 8520A & 8522A

before, after, or both before and after the trigger instant. The storage of readings may be delayed after the trigger, as shown in example D, below.

Stored readings can be recalled individually or scanned in sequence for display on the front panel. Or they may be transferred to a controller or computer via the interfaces available in the 8520A or 8522A. Math processing can be applied to readings stored in memory as they are recalled.

### Burst memory, (400 readings part of Option -010)



With Option -010, the burst memory may capture any group of 400 successive readings that occur within 399 readings prior to and 999 readings following the burst trigger. In example A, only one reading is taken after the trigger point. In example B, 400 readings immediately following the burst trigger are captured. Example C shows storage of 100 readings prior and 300 readings after the trigger point. The last example shows 400 readings being stored commencing 599 readings after the trigger.

### 8522A — Parallel and BCD Interface

Speed and real-time measurement are key system elements available in the 8522A when the Parallel (binary) interface is selected. That interface offers both a three- and a four-wire handshake (switch-selectable) for use with the most popular parallel computer interfaces. A choice of eight- or sixteen-bit messages are selectable at the rear of the instrument.

The BCD interface emulates BCD remote operation of the Fluke 8375A and 8400A, for the convenience of customers who wish to replace these or any of a large variety of older DMMs in their system. Remote control and data output capabilities are the same as those of the 8375A and 8400A. All but the conductance function may be controlled remotely, plus the range filter and external reference.

Output of readings include five BCD digits, an overrange bit, an overload bit, polarity bit, and three coded range bits. Status output includes function, filter, external reference and remote/local.

### 8520A/AS — for MATE Systems

The 8520A/AS is equipped with a built-in interface interpreter which makes it compatible with Modular Automatic Test Equipment (MATE) systems. This capability allows a MATE Test Executive to operate the 8520A/AS on the IEEE-488 bus using Control Interface Intermediate Logic (CIIL). It will operate in either the "CIIL Mode," responding only to CIIL commands or in the "native mode," responding to either CIIL commands or IEEE-488 bus commands. Data transmission is increased to 120,000 characters per second for direct memory access using the CIIL mode.

The 8520A/AS was the first candidate module to become MATE certified.

### 8520A/PRT — Temperature Measurements

The 8520A/PRT is a temperature measurement system consisting of a Rosemount 162N Platinum Resistance Thermometer (PRT) and an 8520A containing a built-in linearization program customized to match the calibration curve of the specific PRT supplied. Temperature is indicated directly in either °C, °F or K with 0.001 degree resolution.

The 8520A/PRT provides a fast, low-cost way of making extremely accurate temperature measurements, or calibrating temperature measurement instruments, in the range of -200°C to +350°C. Systems using four-terminal resistance bridges are much more time-consuming to use, require greater expertise, are limited in their applications, and are far more costly.

Measurements are repeated approximately once per second, making it possible to detect and track fast temperature changes, something impractical to try to do with balance bridges.

## Specifications

### DC Voltage

Range	Full Scale	Resolution	Input Resistance
100 mV	199.999	1 $\mu$ V	$\geq 10,000$ M $\Omega$
1V	1.99999	10 $\mu$ V	$\geq 10,000$ M $\Omega$
10V	16.0100	100 $\mu$ V	$\geq 10,000$ M $\Omega$
100V	130.100	1 mV	10 M $\Omega$
1000V	1024.00	10 mV	10 M $\Omega$

### Accuracy: $\pm$ (% of Input + Digits)

Range	24 Hours 23°C $\pm$ 1°C	90 Days 18°C to 28°C	1 Year 18°C to 28°C	Plus Temp. Coefficient per °C*
100 mV	0.003 + 5	0.0065 + 6	0.011 + 10	0.0005 + 0.5
1V	0.003 + 1	0.006 + 2	0.011 + 2	0.0005 + 0.15
10V	0.002 + 1	0.005 + 1	0.009 + 1	0.0004 + 0.10
100V	0.003 + 1	0.007 + 2	0.012 + 2	0.0005 + 0.15
1000V	0.0035 + 1	0.0065 + 1	0.011 + 1	0.0005 + 0.10

\*From 18°C to 0°C or 28°C to 50°C

### High Speed Accuracy: $\pm$ (% of Input + LS Bit)\*

Range	90 Days 18°C to 28°C	1 Year 18°C to 28°C	Plus Temperature Coefficient Per °C
100 mV	0.01 + 1	0.015 + 1	0.001 + 0.1
1V-1000V	0.01 + 1	0.015 + 1	0.001 + 0.05

\* Typical with 60 Hz line, remote operation, 500 readings per second, 2-byte binary output with 14 bits of data.

### Normal Mode Rejection

Line Freq.	Filter Setting Time					
	25 ms	50 ms	100 ms	200 ms	500 ms	1s
50 Hz	65 dB	68 dB	71 dB	80 dB	83 dB	86 dB
60 Hz	65 dB	68 dB	71 dB	85 dB	88 dB	91 dB

**Common Mode Rejection:** True, 100 dB at 50 Hz and 60 Hz with 1 k $\Omega$  unbalance in either lead. Effective CMR is equal to normal mode rejection plus true CMR

**Maximum Input:**  $\pm 1000$ V peak, High to Low or Guard to chassis terminals, and  $\pm 200$ V peak, Guard to Low terminals, for any range  
**Bias Current:**  $\leq 50$  pA

### Maximum Reading Rate

Operation	Line	Rate	Resolution
Local or Remote	50 Hz	200 rdgs/sec*	5½ digits
	60 Hz	240 rdgs/sec*	
Remote	50 Hz	>500 rdgs/sec	4½ digits
	60 Hz	>500 rdgs/sec	

\*For local operation, 8522A is limited to ½ this rate.



# DIGITAL MULTIMETERS

## 8520A/AS & 8520A/PRT & 8520A & 8522A

### AC Voltage (True - RMS) Input Characteristics

Range	Full Scale	Resolution	Input Impedance
1V	1.99999	10 $\mu$ V	1 M $\Omega$ , $\leq$ 100 pF
10V	16.0100	100 $\mu$ V	
100V	130.100	1 mV	
650V	650.00	10 mV	

Accuracy:  $\pm(\% \text{ Input} + \% \text{ of Full Scale}) \text{ ac or ac+dc}^*$

Frequency	90 Days 18°C to 28°C			1 Year 18°C to 28°C		
	% of Input	+% FS AC	+% FS AC+DC	% of Input	+% FS AC	+% FS AC+DC
10 Hz to 20 Hz**	3.0	0.6	0.7	3.5	0.6	0.7
20 Hz to 40 Hz**	0.5	0.5	0.6	0.6	0.6	0.7
40 Hz to 20 kHz	0.1	0.03	0.08	0.15	0.05	0.16
20 kHz to 100 kHz	1.0	0.3	0.4	2.0	0.6	0.8
100 kHz to 300 kHz	2.4	0.6	0.6	4.0	0.1	0.1
300 kHz to 1 MHz	8.0	2.5	2.5	15.0	5.0	5.0

\*From 0.1% of range to full scale

\*\*With statistics program

Temp. Coefficient: 18°C to 0°C or 28°C to 50°C, to 20 kHz

AC Mode:  $\pm(0.007\% \text{ of input} + 0.007\% \text{ FS})/^{\circ}\text{C}$

AC+DC Mode:  $\pm(0.007\% \text{ of input} + 0.14\% \text{ FS})/^{\circ}\text{C}$

Maximum Input:  $\pm 1000\text{V}$  peak High to Low or Guard to Chassis terminals, and  $\pm 200\text{V}$  peak Guard to Low terminals

Crest Factor:  $\geq 4:1$  at full scale, increasing down scale

Maximum Reading Rate: 10 readings per second

Maximum Slew Rate: 177V per  $\mu$ s

Maximum Volt-Hertz Product:  $2 \times 10^7$

### Resistance

#### Input Characteristics

Range	Full Scale	Resolution	Current Through Unknown	Open Circuit Voltage
10 $\Omega$	19.9999	100 $\mu\Omega$	10 mA	7V
100 $\Omega$	199.999	1 m $\Omega$	10 mA	
1000 $\Omega$	1999.99	10 m $\Omega$	1.0 mA	
10 k $\Omega$	19.9999	100 m $\Omega$	0.1 mA	
100 k $\Omega$	199.999	1 $\Omega$	14.5 $\mu$ A (max)	
1 M $\Omega$	1.99999	10 $\Omega$	1.5 $\mu$ A (max)	
10 M $\Omega$	19.999	1k $\Omega$	1.5 $\mu$ A (max)	

Maximum Input:  $\pm 400\text{V}$  peak for any range

Maximum Reading Rate: 100 k $\Omega$  range and higher, reading rate is 10 rdgs/second

#### 10 k $\Omega$ Range and Lower

Operation	Resolution	Line	Reading Rate
Local or Remote	5 $\frac{1}{2}$ -digits	50 Hz	200 rdgs/sec*
		60 Hz	240 rdgs/sec*
Remote	4 $\frac{1}{2}$ -digits	50 Hz	>500 rdgs/sec*
		60 Hz	>500 rdgs/sec*

\*For local operation, 8522A is limited to  $\frac{1}{2}$  this rate.

Accuracy:  $\pm(\% \text{ of Input} + \text{Digits})$

Range	24 Hours 23°C $\pm$ 1°C	90 Days 18°C 328°C	1 Year 18°C 28°C	Plus Temp Coefficient per $^{\circ}\text{C}^*$
10 $\Omega$	0.0045 + 6	0.0080 + 7	0.0140 + 12	0.0007 + 2.0
100 $\Omega$	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
1000 $\Omega$	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
10 k $\Omega$	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
100 k $\Omega$	0.0040 + 2	0.0090 + 2	0.0140 + 3	0.0012 + 0.2
1 M $\Omega$	0.0090 + 2	0.0160 + 2	0.0200 + 3	0.0020 + 0.2
10 M $\Omega$	0.0300 + 1	0.0440 + 1	0.0450 + 3	0.0030 + 0.2

\*From 18°C to 0°C or 28°C to 50°C

### Conductance

Range: 100 nS (10 M $\Omega$ )-<sup>1</sup>

Full Scale: 99.99

Resolution: 0.01 nS (100,000 M $\Omega$ )-<sup>1</sup>

Accuracy:  $\pm(\% \text{ of Input} + \text{Digits})$

24 Hours 23°C $\pm$ 1°C	90 Days 18°C to 28°C	1 Year 18°C to 28°C	*Plus Temp Coefficient per $^{\circ}\text{C}$
0.04 + 5	0.05 + 5	0.06 + 5	0.004 + 1

\*From 18°C to 0°C or 28°C to 50°C

Maximum Input:  $\pm 400\text{V}$  peak

Maximum Reading Rate: 10 readings per second

### External Reference

Operating Range:  $\pm 0.5\text{V}$  dc to  $\pm 33\text{V}$  dc as long as external reference Low terminal is within  $\pm 16.5\text{V}$  of input Low terminal

Input Impedance: 10,000 M $\Omega$  between external reference High or Low terminals and input Low terminal

### Ratio Accuracy

External Reference Voltage	Accuracy
$\pm 20\text{V}$ to $\pm 40\text{V}$ $\pm V_{\text{min}}$ to $\pm 20\text{V}$	$\pm(A + B + 0.001\%)$ $\pm(A + B + (0.02\% \div  V_{\text{xref}} ))$

A = 10V dc range accuracy for the appropriate period of time

B = Input signal function and range accuracy for the appropriate period of time

$V_{\text{min}}$  = Minimum allowable external reference voltage

$|V_{\text{xref}}|$  = Absolute value of the external reference voltage

Maximum Input:  $\pm 180\text{V}$  peak between external reference High or Low and input Low;  $\pm 360\text{V}$  peak between external reference High and Low

### Transfer Accuracy

The following accuracy specifications apply when:

- Reading rate is 2 readings per second
- Filter settling time is 500 ms
- Warm-up is at least 2 hours
- Quantity measured has same nominal value and frequency as transfer standard
- Measurements are made in one range
- Standard is checked at least every hour
- Ambient temperature remains within  $\pm 1^{\circ}\text{C}$

### DC Voltage

Range	$\pm(\% \text{ of Input} + \text{digits})$
100 mV	0.0020 + 4
1V	0.0020 + 1
10V	0.0010 + 1
100V	0.0020 + 1
1000V	0.0020 + 1

### AC Voltage (all ranges)

Frequency	$\pm(\% \text{ of Input} + \% \text{ of Full Scale})$
10 Hz to 20 Hz	1.0 + 0.2
20 Hz to 40 Hz	0.1 + 0.1
40 Hz to 20 kHz	0.005 + 0.009
20 kHz to 100 kHz	0.100 + 0.030
100 kHz to 1 MHz	0.500 + 0.60



# DIGITAL MULTIMETERS

## 8520A/AS & 8520A/PRT & 8520A & 8522A

### Resistance

Range	$\pm(\% \text{ of Input} + \text{Digits})$
10 $\Omega$	0.0030 + 5
100 $\Omega$	0.0020 + 2
1000 $\Omega$	0.0020 + 2
10 k $\Omega$	0.0020 + 2
100 k $\Omega$	0.0020 + 2
1 M $\Omega$	0.0050 + 2
10 M $\Omega$	0.0100 + 1

Conductance (100 nS range):  $\pm(0.02\% \text{ of input} + 0.02 \text{ nS})$

### General Specifications

**IEEE-488 Interface:** Standard in the 8520A

**Parallel (Binary) and BCD Interface:** Standard in 8522A

**BCD Data Output:** Standard 0V and +5V TTL levels positive true, 8-4-2-1 code. Five BCD digits with an overrange bit, overload, polarity, and three coded range bits. The output also includes the state of the instrument (function, filter, external reference, and remote or local).

**BCD Remote Control:** Standard TTL levels — Logic 1 equals +5V or open, Logic 0 equals 0V or contact closure. Controls all functions (except conductance), range, filter (fast, slow), and external reference. Continuous-command entry and triggered-command entry.

**Parallel:** In bit parallel operation all features and functions can be accessed through the remote interface. Maximum speed in this mode is 520 readings per second

**Format:** Select 8 or 16-bit message format with a rear panel switch

**Handshake:** The handshake configuration is also switch selectable 3- or 4-wire for compatibility with computers, mini-computers, and instrument controllers

**Nonsinusoidal Inputs:** For nonsinusoidal inputs  $\geq 10,000$  counts with frequency components  $\leq 100$  kHz, and the following % of reading to the accuracy specifications

**Temperature:** 0°C to 50°C, operating; -25°C to +75°C non-operation

**Relative Humidity:**  $\leq 95\%$  to 25°C,  $\leq 75\%$  to 40°C,  $\leq 45\%$  to 50°C

**Shock & Vibration:** Meets MIL-T-28800C for Type III, Class 5, Style E

**Power:** 100, 120, 220, or 240V ac,  $\pm 10\%$ , 50 to 60 Hz,  $\leq 50$ W

**Size:** 8.9 cm H x 45.7 cm L x 43.2 cm W (3½ in H x 18 in L x 17 in W)

**Weight:** 9.56 kg (21 lb)

**Included:** Manual, power cord, rear panel mating cable connector(s), serialized and dated calibration certification sheet

### Models

January 1985 prices

8520A DMM with IEEE-488 interface .....	\$2995
8522A DMM with BCD and parallel interface .....	4295
8520A/AS DMM for MATE .....	4295
8520A/PRT Temperature Measurement System .....	6195

### Option

8520A-010* Extended Software Package .....	500
*Included with 8520A/AS and 8522A	

### Accessories (Also see page 55)

Y9111 0.93m, 3 ft Trigger Cable .....	15
Y9112 1.85m, 6 ft Trigger Cable .....	15
Y8133 Test Lead Set .....	20
Y2037 100 $\Omega$ RTD Temperature Probe .....	260
Y8021 1m, IEEE-488 Shielded Cable .....	85
Y8022 2m, IEEE-488 Shielded Cable .....	95
Y8023 4m, IEEE-488 Shielded Cable .....	105
Y8597 Adapter for 8375A, 8400A .....	150
Y8598 3½" Rack Adapter with 22" slides .....	100
Y8599 3½" Rack Adapter only .....	65

### After-Warranty Service (See page 227)

SC1-8520A, per 90-day interval .....	232
SC1-8522A, per 90-day interval .....	260

## DIGITAL MULTIMETER

8860A



8860A

## 8860A — Low Cost IEEE-488 Systems

- Standard measurement functions:  
DC voltage  
AC voltage (true rms)  
DC coupled ac voltage  
Resistance (2T or 4T)
- 1  $\mu$ V resolution and  $\pm 0.004\%$  basic dc accuracy
- IEEE-488 interface option
- Calculating controller option
- High/low limit testing
- Peak reading storage

Central to the design concept of this small, new, 5½-digit precision DMM is the fact that it can be expanded at anytime to be a low-cost, fully programmable measurement system simply by installing one of two powerful options.

The first option (-005) sets a new standard for low-cost DMM systems compatible with IEEE Std 488-1978. The second option (-004) saves you money when your system needs to have a lot of math power but doesn't need an instrument controller.

The basic 8860A is a practical, precision benchtop DMM featuring 5½-digit resolution and 0.01% basic dc 1 year accuracy. Ac voltages may be ac- or dc-coupled using a front panel control, and are measured using true-rms circuits. Resistance can be measured to 20 megohms using two- or four-terminal techniques. All function pushbuttons and most others, have annunciator lights to make it easy at all times to know what functions and modes are active. Small, residual dc or resistance errors may be automatically subtracted out of these measurements using the ZERO pushbutton to store the error. Other basic math and memory functions allow you to do hi/lo limit testing, store an offset value to make differential measurements, and store the highest and lowest readings in a series of measurements. A touch of the white NUM shift pushbutton allows you to directly enter and store numerical values in the appropriate data registers. And the numbers may be recalled and displayed when you wish. These basic features remain available in systems applications, too, of course. A BNC connector on the rear panel allows each measurement to be triggered remotely or from a foot switch or automated test fixture.

## IEEE-488 Interface Option (-005)

With this interface, all front panel controls are programmable and the DMM can output data at 30 readings per second with 3½-digit resolution, or 2.5 readings per second with 5½-digit resolution. A learn mode sends configuration data to the instrument controller. A talk-only mode is also available and lets you operate the 8860A in systems without controllers. Rack adapters are also available for the 8860A. The interface functions are SH1, AH1, T5, L4, SR1, RL1, DC1, and DT1.

## Calculating Controller Option (-004)

A detachable Control Keyboard and one Y8833 Plug-in Memory Cartridge are included with this option. They both plug into the rear panel of the 8860A when the 8860A has the rest of Option -004 installed. A general purpose I/O communications port also is available at the rear panel to use with an instrument printer such as the 2020A (with Option -001) to provide a printed alphanumeric record of data or programs. The I/O port also allows the 8860A to exchange digital data with other sources and to drive control systems, trigger displays or indicators, and perform other tasks related to systems operations. For economy, power, and flexibility this configuration is in a class by itself.

Each Y8833 Memory Cartridge will store up to 100 program steps. The non-volatile cartridges have an internal battery good for at least one year. Programs are very easily written using the 8860A Control Keyboard and you don't need to know any programming language. Each key has a two-digit identifying code that appears as part of the display for each program step. The code is simply the row and column number that defines the position of each key on the keyboard. For example, code 11 identifies the upper lefthand key, labeled SAMPLE above the key.

The key labeled "u" shifts the key functions to the upper labels, and the key labeled "d" shifts the functions down, to correspond with the lower labels.

Programming features include conditionals, indirect addressing, editing, display control, and display format control (fixed, scientific, or engineering). The controller has a four-register stack (X, Y, Z, T), eight conditional branch commands, a nested subroutine capability, and four print functions.

Option -004 and -005 cannot be installed in the same 8860A at the same time.

An example of an application might be to determine the power being dissipated in a 200 ohm resistor by measuring the voltage across it:  $P = E^2 \div R$ . See the sample below.

Keystrokes	Display Code	Step No.	
[d] [LBL] [0] [1]	142201	01	Assign label 01 to program
[u] [SAMPLE]	13.11	02	Take measurement
[d] [x <sup>2</sup> ]	1444	03	Square the measured value
[2]	02	04	
[0]	00	05	Enter value of resistor in circuit
[0]	00	06	
[÷]	71	07	Divide x <sup>2</sup> by 200
[d] [DISP X]	1421	08	Display result
[GTO] [0] [1]	2201	09	Go back to start of program
	3.3333		Example measurement (watts)



## DIGITAL MULTIMETER

8860A

## Rear Inputs Option (-006)

Recommended for rackmount system applications where all connections are made via the rear panel. The connector duplicates the function of the front panel input jacks, which are disconnected when the option is ordered.

## DC External Reference Option (-007)

A rear panel connector provides a means of comparing an unknown dc voltage with an externally-applied dc reference voltage and displaying a precise ratio of the two.

## Specifications

## DC Voltage

**Ranging:** Fully automatic or manual.

**Input Polarity:** Automatic selection and display

## Input Characteristics

Ranges	Input Resistance	Resolution		
		5½ Digits	4½ Digits	3½ Digits*
200 mV 2V	10,000 MΩ	1 μV 10 μV	10 μV 100 μV	100 μV 1 mV
20V 200V 1000V	10 MΩ	100 μV 1 mV 10 mV	1 mV 10 mV 100 mV	10 mV 100 mV 1V

\*Requires Option -004 or -005

**Maximum Input:** 1000V peak from Hi to Lo; 500V peak from Lo to earth; 30V peak from Lo to Guard

**Input Bias Current:** <100 pA at 23°C

**Zero Stability:** 10 μV for 90 days, after 1 hour warm-up

**Common Mode Rejection:** >130 dB at 50 Hz or 60 Hz line, using 5½-digit resolution and no filter and with ≤1 kΩ in either lead. >150 dB with guard

**5½-Digit Accuracy:** ±(% of Input + Digits)\*

Ranges	23°C±1°C	18°C to 28°C		
	24 Hours	90 Days	1 Year	
200 mV	0.004+3	0.008+3	0.01+3	
2V, 20V, 200V, 1000V	0.004+2	0.008+3	0.01+3	

\*Using front panel zero

**5½-Digit Settling Time:** <30 ms with no filter, <300 ms with filter, to 0.01% of input step size

**5½-Digit Normal Mode Rejection:** >60 dB with no filter, >100 dB with filter, 50 Hz or 60 Hz

**4½-and 3½-Digit Accuracy:** ±(% of Input + Digits)\*

Ranges	18°C to 28°C		
	4½ Digits		3½ Digits**
	90 Days	1 Year	1 Year
All	0.01+2	0.015+3	0.1+1

\*Using front panel zero

\*\*Requires Option -004 or -005

**4½-Digit Settling Time:** Same as for 5½ digits

**4½-Digit Normal Mode Rejection:** Same as for 5½ digits

**3½-Digit Settling Time:** <5 ms with no filter, <250 ms with filter, to 0.1% of input size

**3½-Digit Normal Mode Rejection:** None with no filter, >40 dB with filter, 50 Hz to 60 Hz

## AC Voltage (True RMS)

**Ranging:** Fully automatic or manual

**Input Impedance:** 10 MΩ, ≤70 pF

**Coupling Modes:** AC or AC+DC

**Ranges:** 200 mV, 2V, 20V, 200V, 700V

**Bandwidth:** -3 dB at 1 MHz, typical

**Resolution:** Same as for dc voltage

**Crest Factor:** 3 at full range, increasing down range

**Settling Time:** <550 ms to 0.2% of input step size

**5½-Digit Accuracy for AC Mode:** ±(% of Input + Digits)

Frequency**	Ranges**	18°C to 28°C		
		% of Input	Plus Digits	
			90 Days	1 Year
20 Hz to 50 Hz	200 mV >200 mV	0.25 0.25	150 70	150 150
50 Hz to 10 kHz	200 mV >200 mV	0.15 0.15	150 70	150 150
10 kHz to 50 kHz	200 mV >200 mV	0.7 0.4	150 150	300 300
50 kHz to 100 kHz	200 mV >200 mV	2.5 1.0	—	350 350
100 kHz to 300 kHz	All	8.0	—	700

\* From 0.5% of range, except 1% of range to full range for 200 mV range.

For AC+DC mode, add 0.1% of reading and 50 digits

\*\* Limited to 700V rms, 1000V peak, or 2 x 10<sup>7</sup> volt-hertz product, whichever is less

**4½-Digit Accuracy for AC Mode:** ±(% of Input + Digits)

Frequency**	Ranges**	18°C to 28°C		
		% of Input	Plus Digits	
			90 Days	1 Year
20 Hz to 50 Hz	200 mV >200 mV	0.25 0.25	15 10	15 13
50 Hz to 10 kHz	200 mV >200 mV	0.15 0.15	15 10	15 13
10 kHz to 50 kHz	200 mV >200 mV	0.7 0.4	18 18	33 33
50 kHz to 100 kHz	200 mV >200 mV	2.5 1.0	—	38 38
100 kHz to 300 kHz	All	8.0	—	73

\* From 0.5% of range to full range, except 1% of range to full range for 200 mV range. For AC+DC mode, add 0.1% of reading and 50 digits

\*\* Limited to 700V rms, 1000V peak, or 2x10<sup>7</sup> volt-hertz product

## Resistance

**Ranging:** Fully automatic or manual

**Configuration:** 2- or 4-terminal

**Open Circuit Voltage:** <6V

**Maximum Input:** 300V dc or peak ac

## Input Characteristics

Ranges	Resolution			Current Through Unknown
	5½-Digits	4½-Digits	3½-Digits	
200Ω	1 mΩ	10 mΩ	100 mΩ	1 mA
2 kΩ	10 mΩ	100 mΩ	1Ω	1 mA
20 kΩ	100 mΩ	1Ω	10Ω	100 μA
200 kΩ	1Ω	10Ω	100Ω	10 μA
2 MΩ	10Ω	100Ω	1 kΩ	1 μA
20 MΩ	100Ω	1 kΩ	10 kΩ	100 nA

## DIGITAL MULTIMETER

8860A

5½-Digit Accuracy:  $\pm$ (% of Input + Digits)\*

Ranges	23°C $\pm$ 1°C	18°C to 28°C	
	24 Hours	90 Days	1 Year
200 $\Omega$	0.008+4	0.012+4	0.015+4
2k, 20k, 200 k $\Omega$	0.006+2	0.01+2	0.013+2
2 M $\Omega$	0.01+3	0.014+3	0.017+3
20 M $\Omega$	0.07+3	0.09+3	0.10+3

\*Using front panel zero

4½- and 3½-Digit Accuracy:  $\pm$ (% of Input + Digits)\*

Ranges	18°C to 28°C		
	4½ Digits		3½ Digits
	90 Days	1 Year	1 Year
200 $\Omega$ through 2 M $\Omega$	0.01+2	0.02+3	0.1+1
20 M $\Omega$	0.1+2	0.14+3	0.3+1

\*Using front panel zero

## Settling Time\*

Ranges	5½ & 4½ Digits		3½ Digits	
	Filter	None	Filter	None
200 $\Omega$ to 20 k $\Omega$	<300 ms	<100 ms	<300 ms	<15 ms
200 k $\Omega$	<1.1s		<800 ms	
2 M $\Omega$	<650 ms		<500 ms	<70 ms**
20 M $\Omega$	<6.8s	<1.5s**	<4.5s	<600 ms**

\* To 0.01% of step size for 5½- and 4½-digit display. To 0.1% of step size for 3½-digit display

\*\* For these ranges, the filter mode is recommended. This will reduce the effects of noise pickup common to all high impedance measurements.

## Option Specifications

## External Reference (Option) (-007)

Reference Range:  $\pm$ 1.0V dc to 11.0V dcDisplay: 10( $V_{in} \div V_{ref}$ )Input Resistance: 1 M $\Omega$  between Ext Ref Hi and Ext Ref Lo, 1.5 M $\Omega$  between Ext Ref Lo and Input LoMaximum Input:  $\pm$ 11V dc between the Hi and Lo reference terminals and  $\pm$ 11V dc between input Lo and either of the reference terminals5½- and 4½-Digit Accuracy:  $\pm$ (0.01% of  $V_{ref} + 2$  digits)  $\div$  0.1V $_{ref}$ 3½-Digit Accuracy:  $\pm$ (2 digits  $\div$  0.1V $_{ref}$ )

## General Specifications

## Measurement Rates

Display	Line Frequency	Integration Time	Rdgs/s
5½ Digits	50 or 60 Hz	100 ms	2.5
4½ Digits	60 Hz	16 ms	15
	50 Hz	20 ms	12.5
3½ Digits*	50 or 60 Hz	2 ms	$\approx$ 30

\*With Option -004 or -005

Temperature Coefficient:  $\pm$ 0.1 x applicable accuracy specification per °C, outside specified temperature range

Shock and Vibration: MIL-T-28800C

Temperature: 0°C to 50°C, operating; -40°C to +75°C, non-operating

Relative Humidity:  $\leq$ 80% to 35°C;  $\leq$ 70% to 50°CPower: 100, 120, 220, or 240V ac  $\pm$ 10%, 50 or 60 Hz, 17W max

Size: 13.1 cm H x 20.5 cm W x 32.7 cm D (5.15 in x 8.05 in x 12.85 in)

Weight: 3.39 kg (7.48 lb)

Included: Operator's manual, calibration manual, service manual, test leads, power cord

## Model

January 1985 prices

8860A Digital Multimeter ..... \$1395

## Options

8860A-004 Calculating Controller .....	550
8860A-005 IEEE-488 Interface .....	200
8860A-006 Rear Input (only) .....	75
8860A-007 DC External References .....	75
8860A-004K* Field Installable Calculating Controller .....	590
8860A-005K** Field Installable IEEE-488 Interface .....	235
8860A-006K Field Installable Rear Input (only) .....	85
8860A-007K Field Installable DC External References .....	90

\*Includes one Y8833 Memory Cartridge

\*\*May not be installed at same time as Option-004

## Accessories (Also see page 55)

2020A* Universal Printer w/Opt -001 .....	285 + 875
2020A** Universal Printer w/Opt -003 .....	345 + 875
Y7203*** 2 ft PTI Ribbon Cable .....	45
Y2016 7" Rack Adapter, Single .....	90
Y2017 7" Rack Adapter, Dual .....	90
Y2035 Printer Paper .....	65
Y8021 1m, IEEE-488 Shielded Cable .....	85
Y8022 2m, IEEE-488 Shielded Cable .....	95
Y8023 4m, IEEE-488 Shielded Cable .....	105
Y8100 DC or AC Current Probe .....	199
Y8140 Slim Test Leads .....	18
Y8833 Memory Cartridge .....	75
A90 6-Range Current Shunt .....	530
80J-10 10 Amp Current Shunt .....	30
80K-6 High Voltage Probe .....	45
80K-40 High Voltage Probe .....	80
80T-150C Temperature Probe, °C .....	120
85RF 500 MHz RF Probe .....	85

\*For 8860A with Option -004 installed

\*\*For 8860A with Option -005 installed

\*\*\*Y7203 or Y7204 required with 2020A Printer Option -001

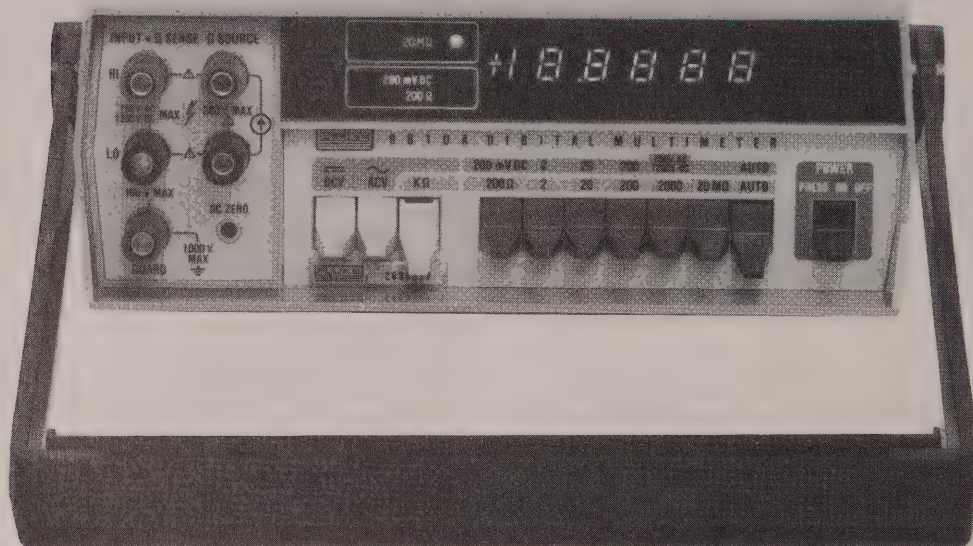
## After-Warranty Service (See page 227)

SC1-8860A, per 90-day interval ..... 220



## DIGITAL MULTIMETER

8810A



8810A

## 8810A, Low Cost Precision

- 5½-digit resolution
- $\pm 0.01\%$  1 year dc basic accuracy
- Autoranging
- Fully guarded
- True rms or avg. ac converter options
- Resistance measurement option
- Data output option

The 8810A is a low cost, high precision, 5½-digit, autoranging digital multimeter that may be bought with or without built-in options. The choice of options not only lets you satisfy specific immediate applications in the most economical way but lets you add capabilities to match changing requirements later.

In its basic configuration the 8810A is simply a dc voltmeter. One option (-07) lets you measure resistance, and either one of two other options lets you measure ac voltage. For sinewaves the Average-Sensing AC Option (-08) is the more accurate. But for waveforms other than pure sinewaves the true-rms AC Option (-09) is more accurate. The 80J-10 Current Shunt, an accessory, is recommended for measuring ac or dc current to 10 amperes.

In the 8810A the long term stability of the reference voltage source is typically 10 ppm. That is ten times better than the 1 year basic dc voltage accuracy specification of 0.01%. DC resolution is 1  $\mu$ V. The guarded input shunts common mode noise current away from the inputs for a 120 dB CMRR.

## Specifications

## DC Voltage

Ranges:  $\pm 200$  mV,  $\pm 2$ V,  $\pm 20$ V,  $\pm 200$ V,  $\pm 1200$ V

Ranging: Full autoranging or manual ranging

Polarity: Automatic, + or - display

Resolution: 1  $\mu$ V on 200 mV range

Accuracy:  $\pm$ (% of input + digits)

Range	24 Hours 23°C $\pm 1^\circ$ C	90 Days 18°C to 28°C	1 Year 18°C to 28°C
200 mV	0.005 + 5	0.008 + 10	0.01 + 10
2V to 200V	0.005 + 2	0.008 + 3	0.01 + 3
1200V	0.005 + 4	0.008 + 6	0.01 + 6

Temperature Coefficient: (18°C to 0°C or 28°C to 50°C)

200 mV Range:  $\pm(0.0007\%$  input + 3 digit)/°C

2V to 1200V Range:  $\pm(0.0007\%$  input + 1 digit)/°C

DC Input Resistance:  $\geq 1000$  M $\Omega$  on 200 mV, 2V, and 20V ranges; 10 M $\Omega$  on 200V and 1200V ranges

Offset Current (at 23°C):  $< 15$  pA on any range; temperature coefficient,  $\pm 5$  pA/°C

Zero Stability: Better than 10  $\mu$ V for 90 days, after 1 hour warm-up

Overload Protection:

$\pm 1200$ V dc or 1700V peak ac on 200V and 1200V ranges

$\pm 1000$ V dc or 1400V peak ac on 200 mV, 2V, and 20V ranges

Normal Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz

Common Mode Noise Rejection:  $\geq 120$  dB at dc, 50 and 60 Hz (with 1 k $\Omega$  in either lead)

Response Time: One second maximum to rated accuracy within range

## Option Specifications

## True-RMS AC Volts Option (-09)

Ranges: 2V, 20V, 200V, 750V

Ranging: Full autoranging or manual ranging

Resolution: 10  $\mu$ V on 2V range

Accuracy:  $\pm$ (% input + digits)

Frequency	24 Hours 23°C $\pm 1^\circ$ C	90 Days 18°C to 28°C	1 Year 18°C to 28°C
45 Hz to 100 Hz	0.25 + 100	0.4 + 200	0.4 + 300
100 Hz to 20 kHz	0.15 + 100	0.2 + 200	0.2 + 300
20 kHz to 50 kHz	0.2 + 150	0.4 + 250	0.4 + 350
50 kHz to 100 kHz	0.8 + 300	1.0 + 400	1.0 + 500

Above accuracy applies from 1% to 100% of range

## DIGITAL MULTIMETER

8810A

**Temperature Coefficient:**  $\pm(0.02\% \text{ input} + 5 \text{ digits})/^{\circ}\text{C}$  from  $18^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  and  $28^{\circ}\text{C} \pm 50^{\circ}\text{C}$

**Input Impedance:** 1 M $\Omega$  shunted by 100 pF

**Crest Factor:** 1:1 to 3:1

**Overload Protection:** 500V dc, 750V rms, or 1100V peak, not to exceed  $1 \times 10^7$  volt-Hz product

**Response Time:** 1.5 seconds maximum to rated accuracy within range

#### Average-Sensing AC Volts Option [-08]

**Ranges:** 2V, 20V, 200V, 750V

**Ranging:** Full autoranging or manual ranging

**Resolution:** 10  $\mu\text{V}$  on 2V range

**Accuracy 2V, 20V, 200V Ranges:**  $\pm(\% \text{ input} + \text{digits})$

Frequency	24 Hours 23°C $\pm 1^{\circ}\text{C}$	90 Days 18°C to 28°C	1 Year 18°C to 28°C
45 Hz to 100 Hz	0.1 + 10	0.2 + 20	0.25 + 30
100 Hz to 10 kHz	0.05 + 5	0.1 + 10	0.1 + 20
10 kHz to 20 kHz	0.1 + 10	0.2 + 20	0.25 + 30
20 kHz to 100 kHz	0.5 + 30	0.8 + 40	1.0 + 60

**Accuracy, 750V Range:**  $\pm(\% \text{ input} + \text{digits})$

Frequency	90 Days, 18°C to 28°C 1 to 500V	500 to 750V	1 Year, 18°C to 28°C 1 to 500V	500 to 750V
45 Hz to 100 Hz	0.25 + 30	0.5 + 30	0.25 + 40	0.50 + 40
100 Hz - 10 kHz	0.15 + 20	0.3 + 20	0.15 + 30	0.30 + 30
10 kHz to 20 kHz	0.25 + 30	0.5 + 30	0.25 + 40	0.50 + 40

Accuracy in above charts applies from 0.1% to 100% of range

#### Temperature Coefficient:

2V to 200V Ranges:  $\pm(0.008\% \text{ input} + 2 \text{ digits})/^{\circ}\text{C}$

750V Range:  $\pm(0.008\% \text{ input} + 4 \text{ digits})/^{\circ}\text{C}$

Above is for  $18^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  and  $28^{\circ}\text{C}$  to  $50^{\circ}\text{C}$

**Input Impedance:** 2 M $\Omega$  shunted by <100 pF

**Overload Protection:** 750V rms, 1100V peak max, not to exceed  $1 \times 10^7$  volt-Hz product

**Response Time:** 1.5 seconds max to rated accuracy within range

#### Resistance Option [-07]

**Ranges:** 200 $\Omega$ , 2 k $\Omega$ , 20 k $\Omega$ , 200 k $\Omega$ , 2000 k $\Omega$ , 20 M $\Omega$

**Ranging:** Full autoranging or manual ranging

**Configuration:** 4-terminal measurements on all ranges

**Resolution:** 1 m $\Omega$  on 200 $\Omega$  range

**Accuracy:**  $\pm(\% \text{ input} + \text{digits})$

Range	24 Hours 23°C $\pm 1^{\circ}\text{C}$	90 Days 18°C-28°C	1 Year 18°C-28°C	Plus Temp Coefficient Per $^{\circ}\text{C}^*$
200 $\Omega$	0.008 + 5	0.01 + 10	0.015 + 10	0.001 + 3
2, 20, 200 k $\Omega$	0.008 + 2	0.01 + 3	0.015 + 3	0.001 + 1
200 k $\Omega$	0.01 + 2	0.015 + 3	0.03 + 3	0.005 + 1
20 M $\Omega$	0.05 + 2	0.1 + 3	0.15 + 3	0.02 + 1

\*From  $18^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  and  $28^{\circ}\text{C}$  to  $50^{\circ}\text{C}$

#### Maximum Current Through Unknown:

Range	200	2k	20k	200k	2000k	20M
Current	1 mA	1 mA	250 $\mu\text{A}$	25 $\mu\text{A}$	2.5 $\mu\text{A}$	0.25 $\mu\text{A}$

**Open-Circuit Voltage:** 3.3V maximum

**Overload Protection:** 250V rms or dc, applied continuously to any range

**Response Time:** 1.0s max to displayed input, 200 $\Omega$  through 200 k $\Omega$ ; 3.0s max to display input, 2000 k $\Omega$  and 20 M $\Omega$  range

#### Data Output Option [-02]

Isolated parallel BCD Output, TTL/DTL compatible levels

#### PTI Interface Option [-521]

For automatically logging measured data using a Fluke 2020A or 2030A Printer. Y7203 interface cable (included) may be paralleled with other Fluke PTI instruments and addressed sequentially by the printer. This option is part of option 8810A-529 and outputs data only

#### 1120A Interface Kit [-522K]

When Kit -522K is added to Option -521 (or Kit -521K) the two perform the same as Option 8810A-529. The Kit consists of a DVM personality card for the Fluke 1120A Translator

#### IEEE-488 Interface Option [-529]

The 8810A will operate with other instruments on the IEEE-488 bus using Option 8810A-529 and the Fluke 1120A Translator, outputs data only

### General Specifications

**Autorange Rate:** 600 ms max per range

**Reading Rate:** 2.5 readings per second within range

**Overload Indication:** Flashing display of +188888 (built-in segment test of LED display) for out of range indication

**Operating Temperature:**  $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$

**MTBF:** 10,000 hours calculated, minimum

**Common Mode Voltage:** 1000V dc or peak ac maximum

**Lo to Guard Voltage:** 100V dc or peak ac maximum

**Power:** 100V, 110V, 230V ac  $\pm 10\%$ , 50 or 60 Hz, 8W

**Size:** 8.9 cm H x 22.9 cm W x 31.8 cm D (3.5 in H x 9 in W x 12.5 in D)

**Included:** Manual, power cord

### Model

January 1985 prices

8810A Digital Multimeter ..... \$895

### Options\*

8810A-02 BCD Data Output .....	200
8810A-07 Resistance .....	199
8810A-07K Field Installable Resistance .....	220
8810A-08 Average Responding AC Volts .....	170
8810A-08K Field Installable Average Responding AC Volts ...	190
8810A-09 True-RMS AC Volts .....	295
8810A-09K Field Installable True-RMS AC Volts .....	325
8810A-521 PTI Output Interface .....	195
8810A-521K PTI Output Interface, kit, field-installable .....	200
8XXXA-522K 1120A Interface, kit, field-installable .....	130
8810A-529 IEEE-488 Output Interface .....	275

\*Option -02 cannot be used with -521, -522, or -529. Option -08 cannot be used with -09. Option -529 is comprised of -521 plus -522.

### Accessories (Also see page 55)

A90 6-Range Current Shunt .....	535
80J-10 Current Shunt .....	30
80K-6 High Voltage Probe .....	45
80K-40 High Voltage Probe .....	80
83RF RF Probe .....	49
85RF RF Probe .....	85
80I-400 Clamp-On Current Probe* .....	69
80I-600 Clamp-On Current Probe* .....	99
80T-150C Temperature Probe ( $^{\circ}\text{C}$ ) .....	120
80T-150F Temperature Probe ( $^{\circ}\text{F}$ ) .....	120
C89 Carrying Case .....	20
M00-200-625 3½" Rack Mount Kit .....	60

\*Use with 80J-10 or A90

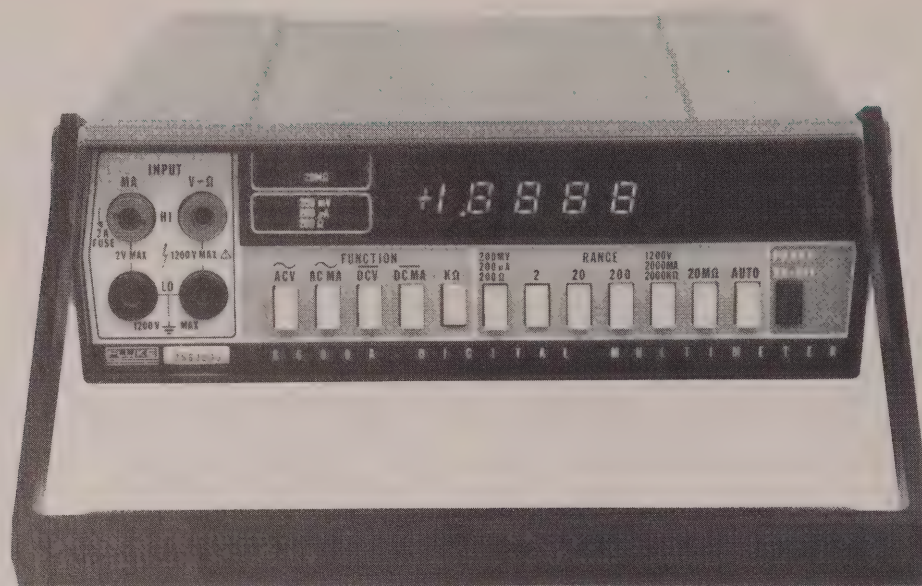
### After-Warranty Service (See page 227)

SC1-8810A, per 90-day interval ..... 116



## DIGITAL MULTIMETER

8600A



8600A

## 8600A. Autoranging

- 4½-digit resolution
- $\pm 0.02\%$  6 month basic dc accuracy
- Autoranging
- Dc and ac voltage ranges to 1200V
- Dc and ac current ranges to 2 amps
- Resistance to 20 M $\Omega$
- Rechargeable battery version
- Data output option

The 8600A is a 4½-digit multimeter featuring high accuracy and full autoranging capability except for current. Measurement functions include ac volts, dc volts, ac current, dc current, and resistance. Available options include a rechargeable battery pack (-01) for portable operation, a parallel BCD printer output (-02), Option -521 for Fluke 2030A or 2020A Printer, and Option -529 for operation on the IEEE-488 bus via the 1120A Translator. Superior reliability is assured through a high impact plastic case, LSI construction, dual slope measurement techniques and extensive input overload protection on all ranges. All dc voltage ranges will withstand  $\pm 1200\text{V}$  dc or 1700V peak ac without damage. Similarly, all ac voltage ranges will endure 1200V rms without damage. The resistance ranges can handle continuous 250V rms or dc inputs without damage. All current ranges are protected by a 2A fuse which is replaceable from the front panel.

## Specifications

All accuracy specifications are for 6 months with a room temperature of 15°C to 35°C.

## DC Voltage

Ranges:  $\pm 200\text{mV}$ ,  $\pm 2\text{V}$ ,  $\pm 20\text{V}$ ,  $\pm 200\text{V}$ ,  $\pm 1200\text{V}$

Ranging: Full autoranging or manual ranging

Polarity: Automatic, + and - displayed

Resolution: 10  $\mu\text{V}$  on 200 mV range

Accuracy:  $\pm(0.02\%$  of input  $+0.005\%$  of range) for 2, 20, 200V ranges;  $\pm(0.02\%$  of input  $+0.008\%$  of range) for 1200V range;  $\pm(0.04\%$  of input  $+0.01\%$  of range) for 200 mV range

DC Input Resistance:  $>1000\text{ M}\Omega$  on 200 mV and 2V ranges. 10 M $\Omega$  on 20V, 200V, and 1200V ranges

Zero Stability: Autozero on all ranges

Overload Protection:  $\pm 1200\text{V}$  dc or  $\pm 1700\text{V}$  peak ac applied continuously to any range

Normal Mode Noise Rejection:  $\geq 60\text{ dB}$  at 50 Hz and 60 Hz

Common Mode Noise Rejection:  $\geq 120\text{ dB}$  (with 1 k $\Omega$  in either lead) at dc, 50 Hz, and 60 Hz

Response Time: 1.0s max to rate accuracy, within range

## AC Voltage (Average-Sensing)

Ranges: 200 mV, 2V, 20V, 200V, 1200V

Ranging: Full autoranging or manual ranging

Resolution: 10  $\mu\text{V}$  on 200 mV range

Accuracy:  $\pm(\%$  of Input  $+\%$  of Range)

Range	30 Hz	50 Hz	10 kHz	20 kHz	50 kHz	100 kHz
200 mV (1% to 100%)	0.5+0.1	0.2+0.08		0.5+0.1	0.5+0.5	
2V, 20V, 200V (1% to 100%)	0.5+0.25	0.2+0.015		0.5+0.25	1.0+0.05	
1200V						
10V-500V	0.5+0.08	0.2+0.03	0.5+0.08			
500V-1200V	0.5+0.08	0.37+0.03	0.5+0.08			Not Specified

Input Impedance: 2 M $\Omega$  shunted by  $<100\text{ pF}$

Overload Protection: 1200V rms maximum, not to exceed  $2 \times 10^7$  volt-hertz product

Response Time: 1.5s max to rated accuracy within range

## DC Current

Ranges: 200  $\mu\text{A}$ , 2 mA, 20 mA, 200 mA, 2000 mA

Ranging: Manual ranging

Resolution: 10 nA on 200  $\mu\text{A}$  range

Accuracy:  $\pm(0.1\%$  of input  $+0.01\%$  of range) on all ranges

Voltage Burden: 0.5V max at 2A, 0.25V max to 200 mA

Overload: Protected to 2A on any range; fused above 2A

Response Time: 1.0s max to rated accuracy within range

## DIGITAL MULTIMETER

8600A

## AC Current

**Ranges:** 200  $\mu$ A, 2 mA, 20 mA, 200 mA, 2000 mA

**Ranging:** Manual ranging

**Resolution:** 10 nA on 200  $\mu$ A range

**Accuracy:** 50 Hz - 10 kHz,  $\pm(0.3\%$  of input + 0.08% of range) all ranges, except 50 Hz - 5 kHz on 2000 mA range; 30 Hz - 50 Hz  $\pm(0.6\%$  of input + 0.1% of range) all ranges

**Voltage Burden:** 0.5V max at 2A, 0.25V max to 200 mA

**Overload:** Protected to 2A on any range; fused above 2A

**Response Time:** 1.0s max to rated accuracy within range

## Resistance

**Ranges:** 200 $\Omega$ , 2 k $\Omega$ , 20 k $\Omega$ , 200 k $\Omega$ , 2000 k $\Omega$ , 20 M $\Omega$

**Ranging:** Full autoranging or manual ranging

**Resolution:** 10 m $\Omega$  on 200 $\Omega$  range

**Configuration:** 2 wire

**Accuracy:**

$\pm(0.1\%$  of input + 0.15% of range) 200 $\Omega$  range

$\pm(0.1\%$  of input + 0.005% of range) 2 k $\Omega$  range

$\pm(0.05\%$  of input + 0.005% of range) 20 k $\Omega$  to 2000 k $\Omega$  range

$\pm(0.2\%$  of input + 0.005% of range) 20 M $\Omega$  range

**Open Circuit Voltage:**  $\leq 5$ V

**Overvoltage Protection:** 250V rms or dc, applied continuously

**Response Time:** 1.0s max to rated accuracy within range, (200 $\Omega$  range to 2000 k $\Omega$  range), 4s max on 20 M $\Omega$  range

## Current Through Unknown

200 $\Omega$	2 k $\Omega$	20 k $\Omega$	200 k $\Omega$	2000 k $\Omega$	20 M $\Omega$
1 mA	1 mA	100 $\mu$ A	10 $\mu$ A	1 $\mu$ A	0.1 $\mu$ A

## Battery Pack Version (8600A-01)

Internal rechargeable battery pack, 8 hours typical operation, rechargeable in 16 hours max. Not compatible with Option -02.

## Digital Output Version (8600A-02)

Isolated parallel BCD output, TTL/DTL compatible levels. Not compatible with Version -01.

## Option Specifications

## PTI Interface Option (-521)

For automatically logging measured data using a Fluke 2020A-004 or 2030A Printer. Y7203 interface cable (included) may be paralleled with other Fluke PTI instruments and addressed sequentially by the printer. This option is part of Option 8600A-529 and only outputs data.

## 1120A Interface Kit (-522K)

When Kit -522K is added to Option -521, (or Kit -521K), the two perform the same as Option 8600A-529. The kit consists of a DVM personality card for the Fluke 1120A Translator.

## IEEE-488 Interface Option (-529)

The 8600A will operate with other instruments on the IEEE-488 bus using Option 8600A-529 and the Fluke 1120A Translator only outputs data.

## General Specifications

**Function:** Selected via front panel controls

**Range:** Automatic or manual, selected via front panel controls

**Autorange Rate:** 600 ms max per range change

**Display:** 7 segments 0.3 LED display, automatic decimal location

**Reading Rate:** 2½ samples/second within range

**Overload Indication:** Flashing display of +18888 (built-in segment test of LED display) for out of range indication

**Temperature:** 0°C to +50°C, operating; -40°C to +75°C, -40°C to +60°C with batteries, non-operating

**Relative Humidity:**  $\leq 80\%$ , +5°C to +35°C;  $\leq 70\%$ , +35°C to +50°C

**Shock and Vibration:** Meets pertinent requirements of MIL-T-28800C

**MTBF:** 10,000 hours calculated, minimum

**Common Mode Voltage:** 1000V dc or peak ac, max

**Power:** 115 or 230V ac  $\pm 10\%$ , 50 or 60 Hz, 7 watts line, 10 watts battery

**Size:** Excluding handle, 6.4 cm H x 19.1 cm W x 25.2 cm D, (2.52 in H x 7.5 in W x 9.9 in D)

**Weight:** 1.6 kg (3.5 lb) line; 2.1 kg (4.5 lb) w/batteries

## Models

January 1985 prices

8600A Digital Multimeter .....	\$775
8600A-01 DMM with rechargeable batteries .....	855
8600A-02 DMM with BCD Data Output .....	950

## Options\*

8600A-521 PTI Interface .....	175
8600A-521K PTI Interface, kit, field-installable .....	200
8XXXA-522K 1120A Interface, kit, field-installable .....	130
8600A-529 IEEE-488 Interface .....	275

\*Not compatible with 8600A-01 or 8600A-02

## Accessories (Also see page 55)

80K-6 High Voltage Probe .....	45
80K-40 High Voltage Probe .....	80
85RF RF Probe .....	85
80T-150C Temperature Probe (°C) .....	120
80T-150F Temperature Probe (°F) .....	120
80i-400 Clamp-On Current Probe .....	69
80i-600 Clamp-On Current Probe .....	99
80J-10 Current Shunt .....	30
M00-100-714 Panel Protector .....	10
M00-200-611 3½" Rack Adapter, Offset .....	35
M00-200-612 3½" Rack Adapter, Center .....	35
M00-200-613 3½" Rack Adapter, Dual .....	50

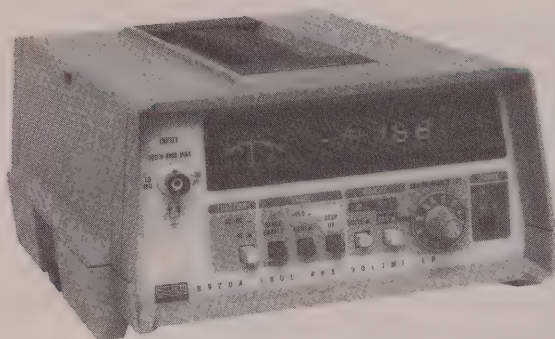
## After-Warranty Service (See page 227)

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# DIGITAL VOLTMETERS

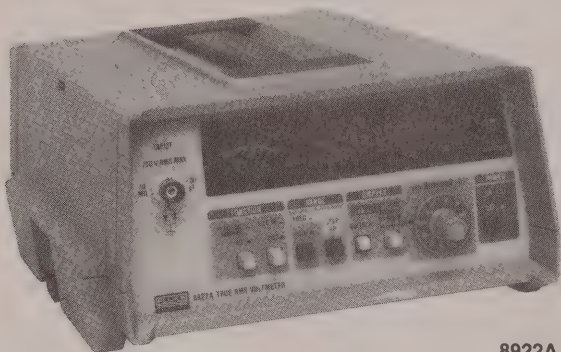
## 8920A/8921A/8922A



8920A



8921A



8922A

### 8920A/8921A/8922A, Wideband

- True-rms ac
- Ac or ac + dc measurements
- Autoranging
- 4-digit display
- Analog display for peak/null adjustments
- Rear panel linear analog output (Models 8920A & 8922A)
- Relative dB reference
- 2 Hz to 11 MHz (Model 8922A)
- 180  $\mu$ V to 700V

### Choice of Bandwidth

Bandwidth capabilities of the 8920-Series Voltmeters extend to every application, from testing high-frequency oscillators, attenuator flatness and amplifier frequency response to microphone

levels, phono-pickup devices, vibration tests and wideband noise levels — to list only a few. Models 8920A and 8921A cover a bandwidth of 10 Hz to 20 MHz. The 8922A offers low-frequency capabilities in the 2 Hz to 11 MHz bandwidth and a switchable 200 kHz low pass filter which eliminates unwanted high-frequency noise from the measured signal.

### Selectable dBm Reference Levels

Fluke's 8920-Series Voltmeters permit an operator to select any one of 12 reference impedances from 50 $\Omega$  to 1200 $\Omega$  and to digitally read out dB values referenced to the selected level. Input impedance is constant at 10 M $\Omega$  for all settings of the dB reference control. This minimizes circuit loading and allows the operator to add the appropriate termination externally. Zero dB corresponds to 1 mW for each of the selectable levels.

### True RMS Converter

The heart of all 8920-Series Voltmeters is Fluke's monolithic thermal converter which can measure rms values of an ac signal. This patented semiconductor circuit balances the heating power of a dc feedback signal against the heating power of the ac input voltage, producing a *true* rms equivalent dc output. This unique converter enables Fluke voltmeters to provide wideband, low-noise, accurate measurements at a low cost.

### AC or AC + DC Functions

Until Fluke introduced its 8920-Series Voltmeters, only the most expensive meters offered ac + dc coupling. Without this feature, whenever an operator is required to measure a signal which (1) is not symmetrical, (2) has unequal excursions above and below zero, or (3) has a dc component, it is necessary to go through a series of computations to determine the actual rms voltage value. First, the signal has to be measured with a dc voltmeter (providing its ac rejection is sufficient) and then with an ac voltmeter. Finally, the sum of the squares of the two readings must be calculated and the square-root extracted from the result. Failure to consider the dc component by using only an ac-coupled meter can result in substantial error.

### Relative dB Reference

The relative reference feature of the 8920-Series Voltmeters allows direct readings of gain or attenuation. Depressing the REL switch sets the existing dB reading to zero, establishing the input voltage level as the relative dB reference. Subsequent readings of higher voltages will be displayed as +dB, lower voltages as -dB.

Meters lacking this feature require an operator to record a desired reference level and then add or subtract it from subsequent readings to arrive at the relative dB value — a tedious and time-consuming procedure.

### Autoranging

Fluke's autoranging feature allows you to carry out your testing without having to change ranges manually. A range can be placed on HOLD or manually stepped up to a higher range. On HOLD, the meter will remain in a given range regardless of changes in input levels. On STEP UP, the meter will increase ranges step-by-step until the switch is released.

### Peaking/Dipping Meter

In addition to an accurate digital display, all Fluke Voltmeters in the 8920-Series feature an analog meter for peak and null voltage adjustments. The meter indicates 0 to 100 percent full scale in each range.

### Linear Analog Output

Models 8920A and 8922A are equipped with a rear panel output for driving X-Y or strip chart recorders, delivering voltages proportional



## DIGITAL VOLTMETERS

8920A/8921A/8922A

to the display count. A 2-volt level equals 2000 counts, a 1-volt level equals 1000 counts, etc. This feature is not available on Model 8921A.

## Accuracy

Fluke Digital Voltmeters avoid the possibilities for error so common in analog meters. The digital displays eliminate the likelihood of misreading the meter due to viewing angle problems of parallax common with analog meters. Also, the accuracy of 8920-Series Voltmeters is specified as a percent of reading rather than as percent of full scale.

Percent of reading accuracy does not degrade for measurements at the low end of a scale. Front panel switching offers a choice of readings in dB or volts.

## Specifications

The accuracy specifications below apply from 9% to 100% of full scale and from 18°C to 28°C for 90 days. For six-month specifications multiply figures by 1.5.

AC Accuracy:  $\pm$  % of voltage reading or  $\pm$  dB (8920A/8921A)

Range	2 Hz	10 Hz	20 Hz	50 Hz	10 kHz	200 kHz	1 MHz	2 MHz	10 MHz	20 MHz
700V 200V	Not Specified									
20V 2V 200 mV	Not Specified	5% or 0.5 dB	1% or 0.15 dB	0.5% or 0.1 dB	0.7% or 0.15 dB	3% or 0.35 dB		5% or 0.5 dB		
20 mV			2% or 0.25 dB	1% or 0.15 dB	2% or 0.25 dB	4% or 0.4 dB				
2 mV			3% or 0.35 dB	2% or 0.25 dB	3% or 0.35 dB					

AC Accuracy:  $\pm$  % of voltage reading or  $\pm$  dB (8922A)

Range	2 Hz	10 Hz	20 Hz	50 Hz	10 kHz	200 kHz	1 MHz	2 MHz	11 MHz
700V 200V	Not Specified								
20V 2V 200 mV	3% or 0.35 dB	5% or 0.5 dB	1% or 0.15 dB	0.5% or 0.1 dB	0.7% or 0.15 dB	3% or 0.35 dB			
20 mV			2% or 0.25 dB	1% or 0.15 dB	2% or 0.25 dB			5% or 0.5 dB	
2 mV			5% or 0.5 dB	3% or 0.35 dB	2% or 0.25 dB	4% or 0.4 dB			

\* Valid when AC + DC DAMPING is selected and input has no dc components.

\*\* Below 2 mV add number of digits (N) to  $\pm 5\%$  voltage readings, where  $N = 5 \div \text{mV input}$ . Or, for dB readings, add N to  $\pm 0.5$  dB, where  $N = 0.05 \div (\text{mV input})^2$ .

**AC+DC Accuracy:** Add to AC accuracy specifications (above)  $\pm 10$  digits or  $\pm 0.5\%$  dB above 2 mV, or  $\pm 100$  digits or  $\pm 5.0$  dB below 2 mV. For dc only, add above digits to 50 Hz to 10 kHz specifications

**Functions:** True RMS measurements only. AC or AC + DC (8920A and 8921A); AC or AC + DC with damping (8922A)

**Maximum Input:** 700V rms or 1000V peak, not to exceed a volt-hertz product of  $1 \times 10^6$  on any range

**Maximum Common Mode Voltage**

8920A and 8922A: 400 mV rms or 600 mV peak

8921A: 500V rms or 700V peak

**AC Common Mode Rejection:**  $\geq 60$  dB at 50 and 60 Hz with 100 $\Omega$  unbalance

**DC Common Mode Rejection:**  $\geq 100$  dB, 100 $\Omega$  unbalance

**Crest Factor:** 7 at full scale, increasing down scale by 7 times the voltage range divided by the voltage input. Degrades below 10 Hz, annunciated when capability exceeded (8922A only)

**Input Impedance:** 10 M $\Omega$  shunted by  $<30$  pF

**Voltage Ranges:** 2 mV, 20 mV, 200 mV, 2V, 20V, 200V, 700V

**Ranging:** Autoranging with HOLD to defeat autoranging and STEP UP for manual ranging. Ranges up at 2000 counts and ranges down at 180

counts

**Decibel Ranges:** In the autorange mode, the instrument appears as though it has a single range spanning 131 dB

**dBm Reference:** Twelve user-selectable impedances are provided to reference a 0 dBm, 1 mW level (50 $\Omega$ , 75 $\Omega$ , 93 $\Omega$ , 110 $\Omega$ , 124 $\Omega$ , 135 $\Omega$ , 150 $\Omega$ , 300 $\Omega$ , 600 $\Omega$ , 900 $\Omega$ , 1000 $\Omega$ , and 1200 $\Omega$ ) (dBV = 1000 $\Omega$ )

**Relative dB Reference:** A voltage input present when this button is pushed is held as "0 dB" reference point. Subsequent readings indicate  $\pm$  deviations from this point

**Voltage Resolution:** 0.05% of ranges (3 $\frac{1}{2}$  digits)

**Decibel Resolution:** 0.01 dB (4 $\frac{1}{2}$  digits)

**Typical -3 dB Points:** 40 MHz on 20 mV thru 20V ranges and 4 MHz on 2 mV range (8920A/8921A); 22 MHz on 2 mV to 20V ranges (8922A)

**Low Pass Filter:** Approximately 200 kHz -3 dB point, on 8922A only

**Reading Rate:** 2.5/s or 1/s with ac + dc with damping (8922A)

**Autorange Rate:**  $<950$  ms or  $<3.5$ s with ac + dc with damping (8922A)

**Response Time:** (To rated accuracy)  $<1.6$ s or  $<7$ s with ac + dc with damping (8922A)

**Readout:** Panel-selectable for volts or dB, automatic decimal point location: analog peaking/dipping meter

**LED Annunciators:** Indicate "mV," "V," "dB," "REL REF," and "2 MHz MAX" for 2 mV range (8920A and 8921A) and "UNCAL" when crest factor limitation exceeded (8922A)

**Overrange:** Flashes maximum reading for that range

**Underrange:** Flashes decimal

**Linear Analog Output:** (8920A and 8922A only) Linear output of 2000 mV dc for a 2000-count readout;  $\pm 1.0\%$  relative to display; essentially 0 $\Omega$  output into a  $\geq 10$  k $\Omega$  load; non-isolated, with output common same as input common

## Option Specifications

## Counter Output Option (-03)

Drives frequency counters. Converts input signal into a 100 mV peak square wave. Greater dynamic range extends the sensitivity of counters to 180  $\mu$ V at the low end and 700V at the high end. Impedance is 50 $\Omega$ . Used with the 8921A, counter can measure signals elevated to 500V rms.

## Logarithmic Analog Output Option (-04)

For 8920A and 8922A only. Provides an analog output voltage proportioned to the logarithm of the input voltage. Plots logarithmically-scaled graphs, dB variations. Zero volts and zero dB on the output correspond with 200  $\mu$ V on input. A 13.1V output corresponds to 700V or 131 dB on the input. Therefore, 2V on the output equals 20 dB, 6V equals 60 dB, etc., making it easy to relate voltage to dB. The option provides a low-cost way of using an X-Y recorder to plot graphs as one continuous curve over any part of the 131 dB range.

## PTI Interface Option (-521)

To use the 8920-Series DVM's with Fluke's own addressable Portable Test Instrument (PTI) byte-serial data bus. Output to Fluke printers, typically. Supplied with 2-foot ribbon cable Y7203.

## 1120A Interface Option (-522)

A "personality card" that fits in the Fluke 1120A IEEE-488 Translator.

## IEEE-488 Interface Option (-529)

The 8920-Series Voltmeters can be made compatible with IEEE Std 488-1978 by using Option -529 in combination with the Fluke Model 1120A Translator. A single 1120A will interface three Fluke instruments to the bus. Option -529 is the same as Option -521 plus Option -522.

## General Specifications

**Temperature:** -40°C to +75°C, non-operating

**Relative Humidity:**  $<80\%$

**Shock:** MIL-T-28800 all classes

**Vibration:** MIL-T-28800, classes 2, 3 & 4

**MTBF:**  $>10,000$  hours



# DIGITAL VOLTMETERS

## 8920A/8921A/8922A

**Power:** 100V, 120V, 220V ac  $\pm 10\%$  or 240V ac  $+4\%$ ,  $-10\%$ , selected by internal switches, 50 to 400 Hz, 10W max

**Size:** 32.6 cm L x 20.3 cm W x 10.5 cm H (12.9 in L x 8.0 in W x 4.3 in H)

**Weight:** 2.47 kg (5.44 lb)

**Included:** Manual, power cord.

### Models

January 1985 prices

8920A DVM, BNC Input, 10 Hz-20 MHz .....	\$1510
8921A DVM, Banana Jack Input, 10 Hz-20 MHz .....	1510
8922A DVM, BNC Input, 2 Hz-11 MHz .....	1510

### Options

892XA-03 Counter Output .....	210
892XA-04* Logarithmic Output (not for 8921A) .....	210
892XA-521 PTI Interface .....	180
892XA-521K PTI Interface, field-installable .....	210
8XXXA-522K 1120A Interface, field-installable .....	130
892XA-529 IEEE-488 Interface .....	260

\*Not compatible with -521, -521K, -529

### Accessories (Also see page 55)

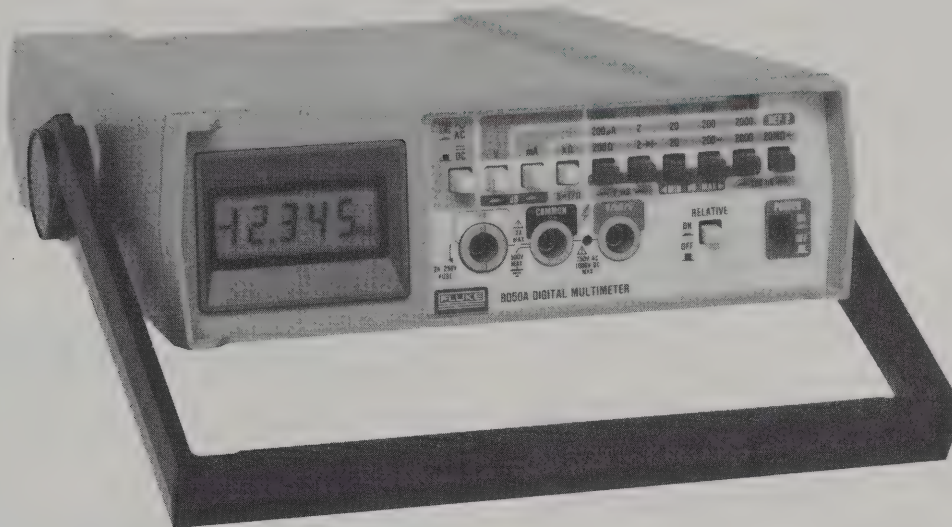
1120A IEEE-488 Translator .....	520
Y7203 2 ft PTI Ribbon Cable .....	45
Y7204 5 ft PTI Ribbon Cable .....	60
Y2014 5/4" Rack Adapter, Single .....	90
Y2015 5/4" Rack Adapter, Dual .....	90
Y2020 Panel Mount Kit .....	90
Y2024 3-Module Power Cord .....	20
A90 6-Range Current Shunt .....	535
80J-10 10 Amp Current Shunt .....	30
Y9103 50 Ohm Feedthrough Terminator .....	30
Y9107 BNC "T" .....	10
Y9109 Banana to BNC Adapter .....	15
Y9111 3-foot BNC to BNC Cable .....	15
Y9112 6-foot BNC to BNC Cable .....	15

### After-Warranty Service (See page 227)

SC1-8920A, per 90-day interval .....	160
SC1-8921A, per 90-day interval .....	160
SC1-8922A, per 90-day interval .....	160

# DIGITAL MULTIMETER

Available through Distributors (See page 248) . . . 8050A



8050A

## 8050A, High Performance Value

- 4½ digits (20,000 counts)
- Nine functions including —  
Relative reference, dB, dBm, dBV, dBW (8Ω),  
Conductance, Diode test
- 0.03% basic dc accuracy
- True-rms from 20 Hz to 50 kHz
- Microprocessor-based
- Extensive overload protection
- Rechargeable battery version (-01)
- Touch-hold probe compatibility (80T-H)
- Probes for rf, high voltage, high current
- Factory Mutual approved

The 8050A provides superior performance and measurement capabilities in a low-cost, benchtop instrument. The 4½-digit DMM has the following measurement functions: Dc volts, true-rms ac volts, dc amps, true-rms ac amps, ohms, dBm (with selectable reference impedances) conductance, and diode test. It also has a relative-reference feature that works with all measurement functions.

### Relative Reference

When the RELATIVE switch is on, the displayed value is equal to the difference between the present input value and a previously stored reference value.

One application is to null out test lead resistance. The resistance of the test leads is first measured and stored in the 8050A. Subsequently, all displayed values of resistance will be actual values since the stored value of lead resistance will be automatically subtracted. Measurement errors are greatly reduced for low values of resistance (about 1Ω or less).

Another application is measuring the dB gain of the various stages of an audio amplifier. First, the input voltage to the amplifier is measured and stored as the zero dB reference value. Subsequent measurements will show the gain of each stage of amplification. Calculations are not needed; the 8050A's microprocessor does it for you.

The relative-reference feature can be used to determine the drift of power supplies, the bandwidth or bandpass of audio devices, and low-pass filter response. This feature makes the 8050A an excellent pass-fail tester for the production line or incoming inspection.

### dB Function

While many analog meters will indicate dBm referenced to 600 ohms, the 8050A provides digital read-out of decibels referenced to any one of sixteen impedances from 8 ohms to 1200 ohms. Now there is no need to use manual conversion tables — the internal microprocessor does the calculations for you. A front panel pushbutton and a scrolling memory lets you select the reference impedance needed.

A resolution of 0.01 dB (above 1 mV) and accuracy specifications from 20 Hz to 50 kHz make the 8050A an extremely valuable tool for audio measurements. It can be used to determine the bandwidth of audio amplifiers, filters, audio consoles, etc. With the addition of an optional rf probe, the 8050A can be used on communications equipment.

### Conductance

Two ranges of conductance extend the resistance-measuring capabilities of the 8050A to 100,000 MΩ, far beyond the capacity of ordinary multimeters. This lets you measure leakage of diodes, pcbs, cables, insulators, even measure transistor beta using a simple test adapter.

### True-RMS AC

The 8050A uses a true-rms conversion technique to assure accurate measurement of non-sinusoidal waveforms as well as pure sinewaves. Examples: distorted or modulated sinewaves, squarewaves, sawtooths, noise, and pulse trains with a duty cycle of 10% or higher. Specified accuracy extends from 20 Hz to 50 kHz. Useful measurements go to 200 kHz, the typical -3 dB bandwidth.

### Optional Touch-Hold Probe

The 80 T-H Probe allows you to "hold" any displayed reading of voltage, resistance, or conductance as long as the control switch on the probe body is depressed. (Not for current or dB measurements.)



# DIGITAL MULTIMETER

8050A . . . Available through Distributors (See page 248)

## Overload Protection

The 8050A has extensive protection against overloads and operator errors. The instrument will accept up to 750V ac or 1000V dc continuously, regardless of the voltage range, or 500V dc when measuring resistance. It will also withstand short-duration transients to 6 kV.

The current input is protected against overloads by an ordinary 2A/250V fuse. For accidental connection of high voltage to the current input terminals (such as 480V ac line power) a heavy duty 3A/600V fuse backs up the first fuse.

## Optional Accessories

Fluke offers a complete line of optional accessories that enable you to measure rf voltages to 500 MHz, temperature to 150°C, current to 600A, or high voltage to 40 kV.

## Specifications

All accuracy specifications apply for one year after purchase or recalibration when operated in a temperature of 18°C to 28°C and a relative humidity of 90% or less.

### DC Voltage\*

Ranges:  $\pm 200$  mV,  $\pm 2$  V,  $\pm 20$  V,  $\pm 200$  V, and  $\pm 1000$  V

Resolution: 10  $\mu$ V on lowest range, 0.1V on 1000V range

Accuracy:  $\pm(0.03\%$  of reading + 2 digits) all ranges

Input Impedance: 10 M $\Omega$ ,  $\leq 100$  pF, all ranges

Normal Mode Noise Rejection:  $\geq 60$  dB at 50 Hz or 60 Hz

Common Mode Noise Rejection:  $\geq 90$  dB at dc, 50 Hz, and 60 Hz with 1 k $\Omega$  unbalance

Overload Protection: 1000V dc or peak ac, continuous, except 10 seconds maximum on the 200 mV and 2V ranges

Response Time: 1 second maximum, to rated accuracy within a range

\*DC voltage can also be measured using the dB mode with 0.01 dB resolution between 5% of range and full range

### AC Voltage (True-RMS, AC Coupled)

Voltage Readout: From 5% to 100% of range

Range	Resolution	Accuracy: $\pm(\%$ of Rdg + Digits)				
		20 Hz*	45 Hz	1 kHz	10 kHz	20 kHz
200 mV	10 $\mu$ V	1% + 10	0.5% + 10	1% + 10	5% + 30	Not specified
2V	100 $\mu$ V					
20V	1 mV					
200V	10 mV					
750V	100 mV					

\*Typically 3 to 5 digits of "rattle" will be observed at 20 Hz at full scale

dB Readout: From 5% to 100% of range

Input Voltage	dBm 600Ω Ref	Range	Accuracy					
			20 Hz	45 Hz	1 kHz	10 kHz	20 kHz	50 kHz
0.77 mV-2 mV	-60 -52	200 mV*	±0.5 dBm					
0.1V-2V	-18 +8	2V*	±0.25 dBm	±0.15 dBm	±0.25 dBm	±0.75 dBm	Not specified	
1V-20V	+2 +28	20V						
10V-200V	+22 +48	200V						
100V-750V	+42 +60	750V						

\* When 200 mV range is selected, 8050A autoranges for best accuracy for inputs up to 2V

dB Resolution:  $\pm 0.01$  dB from 5% to 100% of range; 0.1 dB from 1% to 5% of range; 1.0 dB below 1% of range

Decibel Reference Impedances: Fifteen user-selectable impedance reference levels are provided to reference a 0 dBm, 1 mW level (50 $\Omega$ , 75 $\Omega$ , 93 $\Omega$ , 110 $\Omega$ , 125 $\Omega$ , 135 $\Omega$ , 150 $\Omega$ , 250 $\Omega$ , 300 $\Omega$ , 500 $\Omega$ , 600 $\Omega$ , 800 $\Omega$ ,

900 $\Omega$ , 1000 $\Omega$ , 1200 $\Omega$ ). An 8 $\Omega$  impedance reference level is provided to reference 0 dBW. (dBV = 1000 $\Omega$ )

Input Impedance: 10 M $\Omega$ ,  $\leq 100$  pF, all ranges

Extended dB Response: Typically -72 dBm (600 $\Omega$  ref)  $\pm 1$  dB to 10 kHz

Useful Frequency Range: Typically -3 dB at 200 kHz

Crest Factor: Waveforms with peak/rms ratio of 1:1 to 3:1

Common Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz with 1 k $\Omega$  unbalance

Overload Protection: 750V rms or 1000V peak continuous, except 10 seconds maximum on the 200 mV and 2V ranges, not to exceed a volt-hertz product of  $10^7$  (e.g., 200V at 50 kHz)

Response Time: 2 seconds max to rated accuracy within a range

### DC Current

Range	Resolution	Accuracy (5% to 100% of Range)	Burden Voltage
200 $\mu$ A	10 nA	$\pm(0.3\%$ of rdg + 2 digits)	0.3V max
2 mA	100 nA		
20 mA	1 $\mu$ A		
200 mA	10 $\mu$ A		
2000 mA	100 $\mu$ A		0.9V max

Overload Protection: 2A/250V and 3A/600V fuse in series

### AC Current (True-RMS, AC Coupled)

Range	Resolu- tion	Accuracy: $\pm$ (% of Rdg + Digits)*				
		20 Hz**	45 Hz	2 kHz	10 kHz	20 kHz
200 $\mu$ A 2 mA 20 mA 200 mA	10 nA 100 nA 1 $\mu$ A 10 $\mu$ A	2% + 10	1% + 10	2% + 10		
2000 mA	100 $\mu$ A			Not specified		

\* 5% to 100% of range

\*\* Typically 3 to 5 digits of "rattle" will be observed at 20 Hz at full range

Burden Voltage: 0.3V rms max, 200  $\mu$ A through 200 mA range; 0.9V max on 2000 mA range

Crest Factor: Waveforms with peak/rms ratio of 1:1 to 3:1

Overload Protection: 2A/250V and 3A/600V fuse in series

### Resistance

Range	Resolution	Accuracy	Full Scale Voltage
200 $\Omega$	0.01 $\Omega$	$\pm(0.1\%$ reading + 2 digits + 0.02 $\Omega$ )	0.19V
2 k $\Omega$ *	0.1 $\Omega$		1.2V
20 k $\Omega$	1 $\Omega$	$\pm(0.05\%$ reading + 2 digits)	0.2V
200 k $\Omega$ *	10 $\Omega$		2V
2000 k $\Omega$	100 $\Omega$	$\pm(0.25\%$ reading + 3 digits)	0.2V
20 M $\Omega$ *	1 k $\Omega$		2V

\*Diode Test ranges

Diode Test: The three diode test ranges are marked with a diode symbol and have enough open circuit voltage to turn on silicon junctions allowing a diode test. The 2 k $\Omega$  range is preferred and is marked with the larger diode symbol. The three non-diode test ranges will not turn on silicon junctions when making in-circuit resistance measurements.

Open Circuit Voltage: Less than 3.5V on all ranges

Input Protection: 500V dc or rms ac on all ranges

Response Time: (To rated accuracy) 10 seconds maximum on 20 M $\Omega$  range, 2 seconds maximum on all other ranges

### Conductance

Range	Resolution	Accuracy
2 mS	0.1 $\mu$ S	$\pm(0.1\%$ of reading + 5 digits) $\pm(0.5\%$ of reading + 20 digits)
200 nS	0.01 nS	

# DIGITAL MULTIMETERS

Available through Distributors (See page 248) . . . 8050A

## Equivalent Resistance

2 mS Range: 500 $\Omega$  to 10 M $\Omega$

200 nS Range: 5 M $\Omega$  to 100,000 M $\Omega$

**Open Circuit Voltage:** Less than 3.5V on both ranges

**Input Protection:** 500V dc or rms ac on all ranges

## Relative Reference

An input applied when the RELATIVE button is depressed is held as "0" reference point. Subsequent readings indicate deviations  $\pm$  from this point

**Accuracy:** Error will not exceed the sum of the errors for the two measurements

## General Specifications

**Common Mode Voltage:** 500V dc or peak ac max

**Temperature:** 0°C to 50°C, operating; -40°C to +70°C non-operating, except -40°C to +50°C with batteries

**Temperature Coefficient:**  $\leq 0.1$  times the applicable accuracy specification per °C from 18°C to 0°C and from 28°C to 50°C

**Relative Humidity:**  $\leq 70\%$  to 50°C or  $\leq 90\%$  to 35°C, except 2000 k $\Omega$ , 20 M $\Omega$ , and 200 nS ranges where it is  $\leq 80\%$  to 35°C

**Standards:** IEC 348, Protection Class I when operated from supply mains or Protection Class II when operated from internal batteries

**Power:** 90 to 110V ac, 105 or 132V ac, or 200 to 264V ac, 47 to 440 Hz, factory-configured for customer-specified voltage. With rechargeable battery version (-01), the line voltage range is field-changeable. 4W max, 6W max with -01 version.

**Batteries:** NiCd batteries are installed in version -01. They provide 10 hours of typical operation on a full charge. Recharge takes 14 hours. Can run on ac line while charging.

**Size:** 22 cm W x 6 cm H x 25 cm L (8.5 in W x 2.5 in H x 10 in L)

**Weight:** 1.08 kg (2.38 lb) for standard model

**Included:** Manual, line cord, test leads (Y8132)

and statement of calibration practice

## Models

January 1985 prices

8050A DMM	\$389
8050A-01 DMM with rechargeable batteries	439

## Accessories (Also see page 55)

Y8132 Replacement Test Leads	10
TL70 Test Lead Set	5
Y8134 Deluxe Test Lead Set	20
Y8140 Slim Test Leads, w/needle points	18
Y8205 Soft Carrying Case w/shoulder strap	35
80K-6 High Voltage Probe	45
80K-40 High Voltage Probe	80
83RF 100 MHz RF Probe	49
85RF 500 MHz RF Probe	85
80T-150C Temperature Probe (°C)	120
80T-150F Temperature Probe (°F)	120
80i-400 AC Current Probe	69
80i-600 AC Current Probe	99
Y8100 DC/AC Current Probe	199
Y8101 AC Current Probe	59
80J-10 Current Shunt	30
80T-H Touch-Hold Probe	45
C86 Ruggedized Carrying Case	20
M00-200-611 3½" Rack Adapter, Offset	35
M00-200-612 3½" Rack Adapter, Center	35
M00-200-613 3½" Rack Adapter, Dual	50

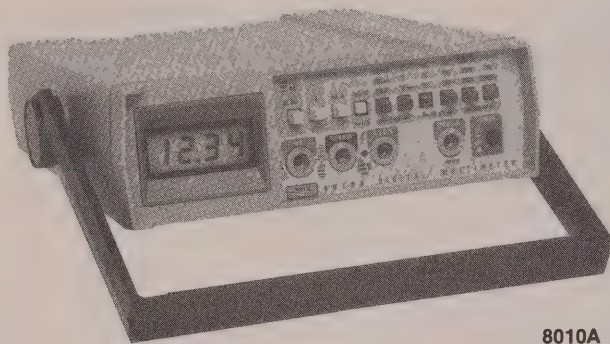
## After-Warranty Service (See page 227)

SC1-8050A, per 90-day interval	48
SC1-8050A-01, per 90-day interval	52

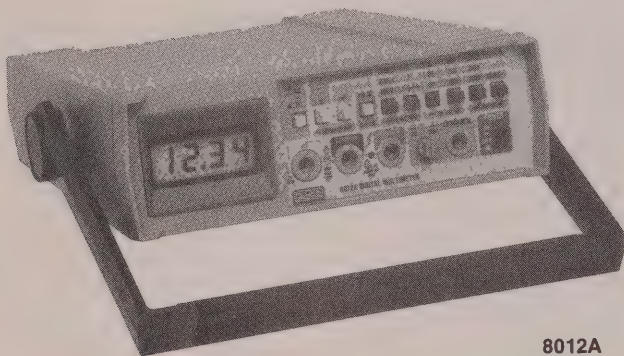


# DIGITAL MULTIMETERS

8010A/8012A . . . Available through Distributors (See page 248)



8010A



8012A

## 8010A & 8012A. Measurement Versatility

- 3½ digits (2000 counts)
- Seven functions, including — Conductance, Diode Test
- 0.1% basic dc accuracy
- True-rms ac, from 45 Hz to 50 kHz
- 10A range (8010A only)
- 2Ω and 20Ω range (8012A only)
- Optional touch-hold probe (80T-H)
- Extensive overload protection
- Rechargeable-battery model (-01)
- Extended measurements with optional accessories
- Factory Mutual approved

The 8010A and 8012A are 3½-digit portable/bench DMMs, that offer exceptional performance and features at a low cost. Measurement functions include: Dc volts, true-rms ac volts, dc amps, true-rms ac amps, ohms, conductance, and diode test. The difference is that only the 8012A features two low-resistance ranges (2 ohms and 20 ohms) and the 8010A features a 10A current range. Rechargeable-battery versions are available as Models 8010A-01 and 8012A-01. The 8010A and 8012A operate on ac line power only.

### True-RMS

A Fluke-manufactured true-rms converter assures accurate measurements of non-sinusoidal voltage or current waveforms such as squarewaves (crest factor of 1 to 1). The custom hybrid provides low noise and a wide bandwidth. Accuracy is specified to 50 kHz, but the typical -3 dB bandwidth is 200 kHz.

### Conductance

This unique and highly useful function makes resistance measurements as high as 10,000 MΩ possible. Since conductance, which is expressed in Siemens (S), is the inverse of ohms (1/Ω), a simple conversion of the DMMs conductance reading yields resistance. The conductance function is useful for checking high-value resistors, leakage in connectors, cables, printed circuit boards, diodes, photodiodes, etc. Even the beta of a transistor may be measured using a simple adapter.

### 10A Range (8010A Only)

The 8010A has a 10 ampere ac or dc current range for applications that require measuring more than 2 amperes.

### Low Ohms (8012A Only)

The 8012A has two additional ranges of low resistance — 2 ohms and 20 ohms. Along with the conductance function, that gives you a resistance range of 0.001Ω to 10,000 MΩ! There are not many resistance measurements that the 8012A can't handle.

The two low-resistance ranges are suited for measuring transformer windings, cables, heating elements, coils, small-value resistors, and many other devices. Lead resistance is nulled out using a front panel control so that only the unknown resistance is measured.

### Optional Touch-Hold Probe

The 80T-H probe lets an operator "hold" the displayed reading by simply depressing a button on the probe's body. The reading will not change until the button is released. The 80T-H can be used as a normal probe at other times. It works for voltage, resistance, and conductance measurements.

### Overload Protection

When measuring resistance or conductance, up to 500 volts may be applied with no instrument damage. Voltage inputs can handle 1000V dc or peak ac and transients up to 6 kV. The 2A current input is protected with two in-series fuses — 2A/250V and 3A/600V. In normal overload situations, only the common 2A/250V fuse will blow. The 3A/600V back-up fuse protects the DMM should the 2A/250V fuse ionize when accidentally attached to a source of more than 250 volts — like a 480-volt power line.

### Extended Measurements

Optional accessories enable you to extend the measurement capabilities of the 8010A and 8012A. For example, measure current to 600A, rf voltage to 500 MHz, voltage to 40 kV, and temperature to 150°C (302°F).

### Specifications

All accuracy specifications are for one year after purchase or recalibration when operated in a temperature of 18°C to 28°C

#### DC Voltage

Ranges: ±200 mV, ±2V, ±20V, ±200V, ±1000V

Resolution: 100 μV on lowest range, 1V on 1000V range

Accuracy: (±0.1% of reading +1 digit) on all ranges

Input Impedance: 10 MΩ on all ranges

Normal Mode Noise Rejection: ≥60 dB at 60 Hz or 50 Hz

Common Mode Noise Rejection: ≥90 dB at dc, 50 Hz, and 60 Hz, with 1 kΩ unbalance

Overload Protection: To 1000V dc or peak ac on any range

Response Time: 1 second maximum

## DIGITAL MULTIMETERS

Available through Distributors (See page 248) . . . 8010A/8012A

## AC Voltage (True-RMS, AC Coupled)

Range	Resolution	Accuracy: $\pm$ (% of Reading + Digits)*			
		45 Hz	1 kHz	10 kHz	20 kHz
200 mV	100 $\mu$ V				
2V	1 mV				
20V	10 mV	0.5% + 2	1.0% + 2	5% + 3	
200V	100 mV				
750V	1V	0.5% + 2	Not specified		

\*Accuracy applies from 5% to 100% of range.

**Useful Frequency Range:** Typically  $\pm 3$  dB at 200 kHz**Input Impedance:** 10 M $\Omega$  in parallel with <100 pF**Common Mode Noise Rejection:**  $\geq 60$  dB at 50 and 60 Hz with 1 k $\Omega$  unbalance**Crest Factor:** Waveforms with peak/rms ratio of 1:1 to 3:1**Overload Protection:** To 750V rms, 1000V peak, not to exceed  $10^7$  volt-hertz product (10 seconds maximum on 200 mV and 2V ranges)**Response Time:** 2 seconds maximum

## Resistance

Range	Resolution	Accuracy $\pm$ (% of Rdg + Digits)	Full Scale Voltage	Max Test Current
2 $\Omega$	1 m $\Omega$	1.0% + 2	0.02V	10 mA
20 $\Omega$	10 m $\Omega$	0.5% + 2	0.20V	10 mA
Note. . . above ranges in 8012A only				
200 $\Omega$	0.1 $\Omega$		<0.25V	1.30 mA
2 k $\Omega$ *	1 $\Omega$		>1.00V	1.30 mA
20 k $\Omega$	10 $\Omega$	0.2% + 1	<0.25V	10.0 $\mu$ A
200 k $\Omega$ *	100 $\Omega$		<1.00V	35.0 $\mu$ A
2000 k $\Omega$	1 k $\Omega$		<0.25V	0.10 $\mu$ A
20 M $\Omega$ *	10 k $\Omega$	0.5% + 1	>1.5V	0.35 $\mu$ A

\*Diode Test ranges.

**Diode Test:** The three diode test ranges are marked with a diode symbol and have enough open circuit voltage to turn on silicon junctions allowing a diode test. The 2 k $\Omega$  range is preferred and is marked with the larger diode symbol. The non-diode test ranges will not turn on silicon junctions when making in-circuit resistance measurements.

**Open Circuit Voltage:** <3.5V on all ranges except <16V on 2 $\Omega$  and 20 $\Omega$  ranges

**Input Protection:** To 300V dc or rms on 2 $\Omega$  and 20 $\Omega$  ranges. 500V dc on all other ranges

**Response Time:** 1 second on all ranges except 2000 k $\Omega$  and 20 M $\Omega$  where time is 4 seconds, maximum

## Conductance

Conductance is the inverse of ohms (1/ $\Omega$ ) and is expressed in Siemens (S), formerly mhos

Range	Resolution	Accuracy $\pm$ (% of Rdg + Digits)	Open Circuit Voltage	Max Test Current
2 mS	1 $\mu$ S	0.2% + 1	<3.5V	1.3 mA
20 $\mu$ S	10 nS	0.2% + 1	<1.0V	10 $\mu$ A
200 nS	0.1 nS	1.0% + 10	<1.0V	0.1 $\mu$ A

## Equivalent Resistance

2 mS Range: 500 $\Omega$  to 1 M $\Omega$ 20  $\mu$ S Range: 50 k $\Omega$  to 100 M $\Omega$ 200 nS Range: 5 M $\Omega$  to 10,000 M $\Omega$ **Input Protection:** To 500V dc or rms on all ranges

## DC Current

Range	Resolution	Accuracy $\pm$ (% of Rdg + Digits)	Burden Voltage
200 $\mu$ A	0.1 $\mu$ A		
2 mA	1 $\mu$ A		
20 mA	10 $\mu$ A	0.3% + 1	
200 mA	100 $\mu$ A		
2000 mA	1 mA		0.9V max
10A*	10 mA	0.5% + 1	0.5V max

\*This range in 8010A only

**Overload Protection:** 2A, 250V front panel fuse in series with 3A/600V internal fuse. 10 ampere range in 8010A not fused, 12A maximum

**Response Time:** 1 second maximum

## AC Current (True-RMS, AC Coupled)

Range	Accuracy $\pm$ (% of Rdg + Digits)*				Burden Voltage
	45 Hz	2 kHz	10 kHz	20 kHz	
200 $\mu$ A					
2 mA					
20 mA		1% + 2		2% + 2	0.3V max
200 mA					
2000 mA		1% + 2	Not specified		0.9V max
10A**					0.5V max

\*Applies from 5% to 100% of range

\*\*This range in 8010A only

**Crest Factor:** Waveforms with peak/rms ratio of 1:1 to 3:1**Response Time:** 2 seconds maximum**Other Specifications:** Same as for dc current

## General Specifications

**Display:** 3½ digit (2000 counts), LCD, autozero, autopolarity**Common Mode Voltage:** 500V dc or peak ac, maximum

**Touch and Hold:** Holds a voltage or resistance reading when the mA jack is momentarily shorted to COMMON. Accessory probe 80T-H is recommended

**Temperature:** 0°C to +50°C, operating; -40°C to +60°C non-operating, except -40°C to +50°C with batteries

**Temperature Coefficient:** <0.1 times the applicable accuracy specification per °C, from 18°C to 0°C and 28°C to 50°C

**Relative Humidity:**  $\leq 70\%$  to 50°C or  $\leq 90\%$  to 35°C except for 2000 k $\Omega$ , 20 M $\Omega$ , and 200 nS ranges where it is  $\leq 80\%$  to 35°C

**Power:** 90 to 132V ac or 200 to 264V ac, 50 or 60 Hz, 2W for standard models. With battery version (-01), voltage and frequency range is selectable with internal switches, 3.5W

**Batteries:** Rechargeable NiCd batteries and recharge circuits installed in version -01. Recharge time approximately 14 hours. "BT" on display appears when approximately ½ hour of operation remains. Fifteen to thirty hours of operation typical on full charge, depending on functions used

**Size:** 6 cm H x 22 cm W x 25 cm D (2.5 in H x 8.5 in W x 10 in D)

**Weight:** 1.8 kg (2.38 lb) for standard models. 1.42 kg (3.13 lb) for version -01 with batteries

**Included:** Manual, line cord, test leads (Y8132), statement of calibration practice



# DIGITAL MULTIMETERS

8010A/8012A . . . Available through Distributors (See page 248)

## Models

January 1985 prices

8010A DMM w/10A Range	\$279
8010A-01 DMM w/Batteries	319
8012A DMM w/2 $\Omega$ and 20 $\Omega$ Range	359
8012A-01 DMM w/Batteries	399

## Accessories (Also see page 55)

Y8131 Replacement Test Leads	10
Y8133 Deluxe Test Lead Set	20
Y8140 Slim Test Leads w/needle points	18
Y8205 Soft Carrying Case	35
80K-6 High Voltage Probe	45
80K-40 High Voltage Probe	80
83RF 100 MHz RF Probe	49
85RF 500 MHz RF Probe	85
80T-H Touch and Hold Probe	45
80T-150C Temperature Probe, °C	120

80T-150F Temperature Probe, °F	120
80i-400 AC Current Probe	69
80i-600 AC Current Probe	99
Y8100 DC/AC Current Probe	199
Y8101 AC Current Probe	59
80J-10 Current Shunt	30
C86 Ruggedized Carrying Case	20
M00-200-611 3½" Rack Adapter, Offset	35
M00-200-612 3½" Rack Adapter, Center	35
M00-200-613 3½" Rack Adapter, Dual	50

## After-Warranty Service (See page 227)

SC1-8010A, per 90-day interval	20
SC1-8010A-01, per 90-day interval	23
SC1-8012A, per 90-day interval	25
SC1-8012A-01, per 90-day interval	28

# HANDHELD MULTIMETERS

## Introduction

Over the past two decades, Digital Multimeters have evolved to become basic and versatile tools of the electronics industry. These troubleshooting devices are used not only to measure volts, ohms, and amps, but, when combined with the wide variety of available accessories, can also measure temperature, rf, high current, and high voltage. Today it is quite common to find DMMs and their accessories in the toolkits of engineers, computer service technicians, TV or appliance repair people, and in the toolkits of hobbyists or homeowners.

Since Fluke's entrance into the DMM market in 1969 our underlying strategy has been to design instruments that provide our customer with:

- Increased performance and reliability
- Reduced size
- Enhanced ruggedness
- Reduced cost

Next in the design process, we incorporate universal convenience features such as autoranging, Touch-Hold, Peak-Hold, Min/Max Hold, and Relative (offset storage) that enhance basic operation.

We then address specific work applications in the most efficient way by making available a variety of accessories.

The selection guide below summarizes the features of Fluke handheld multimeters. Note especially our newest DMMs, the Models 25, 27, and 8025A. These 3½-digit, 3200 count multimeters combine increased accuracy and the features found in the highly successful Fluke 77 with enhanced ruggedness needed for use in high and low temperatures, high moisture, and just hard use. See page 40 for specifications on the Fluke 25 and 27, and page 42 for the 8025A.

## Selection Guide

Models	Basic Features			Special Features								DC Volts**		AC Volts				AC & DC Amps		Ohms, etc.						
	Max Display Counts*	Autoranging	Analog Bar Graph	Frequency Measurement	dB, dBrn Readout	Offset/Relative Ref	Continuity & Buzzer	Peak-Hold, AC/DC	Touch- Hold	Sealed Case	Water/Chemical Resistant	Min/Max Hold	Basic Accuracy, %	Max Resolution, $\mu$ V	Max AC Voltage, w/o Probe (RMS)	True-RMS	Basic Accuracy, %	Max Resolution, $\mu$ V	Frequency Range, Hz	Max Resolution, nA	Max Amps, w/o Probe	Max Resolution, m $\Omega$	Max Resistance, M $\Omega$	Diode Test	Conductance	Page
Handheld Multimeters																										
Fluke 73	3200	●	●	—	—	—	—	—	—	—	—	—	0.7	100	750	—	3.0	1k	1k	10M	10	100	32	●	—	36
Fluke 75	3200	(1)	●	—	—	—	●	—	—	—	—	—	0.5	100	750	—	2.0	1k	1k	10k	10	100	32	●	—	36
Fluke 77	3200	(1)	●	—	—	—	●	—	●	—	—	—	0.3	100	750	—	2.0	1k	1k	10k	10	100	32	●	—	36
Fluke 25	3200	(1)	●	—	—	—	●	—	●	●	—	—	0.1	100	1000	—	0.5	100	30k	100	10	100	32	●	●	39
Fluke 27	3200	(1)	●	—	—	●	●	—	●	●	●	—	0.1	100	1000	—	0.5	100	30k	100	10	100	32	●	●	39
8025A	3200	(1)	●	—	—	—	●	—	●	—	—	—	0.2	100	1000	—	0.5	100	30k	100	10	100	32	●	●	42
8024B	2000	—	—	—	—	—	●	●	(4)	—	—	—	0.1	100	750	—	0.75	100	5k	1k	2	100	20	●	●	44
8026B	2000	—	—	—	—	—	●	—	—	—	—	—	0.1	100	750	●	0.5	100	10k	1k	2	100	20	●	●	47
8020B	2000	—	—	—	—	—	●	—	—	—	—	—	0.1	100	750	—	0.75	100	5k	1k	2	100	20	●	●	47
8021B	2000	—	—	—	—	—	●	—	—	—	—	—	0.25	100	750	—	1.0	100	450	1k	2	100	20	●	—	49
8022B	2000	—	—	—	—	—	—	—	—	—	—	—	0.25	100	750	—	1.0	100	450	1k	2	100	20	●	—	49
8060A	20000	—	—	(2)	●	●	●	—	—	—	—	—	0.04	10	750	●	0.2	10	100k	10	2	10	300	(3)	●	51
8062A	20000	—	—	—	—	●	●	—	—	—	—	—	0.05	10	750	●	0.5	10	30k	10	2	10	300	(3)	—	51

● Standard

\*All displays LCD

\*\*Max DC Voltage W/O Probe 1000V  
All Handheld DMMs

(1) Or manual ranging

(2) For frequencies to 200 kHz

(3) 1 mA constant current mode

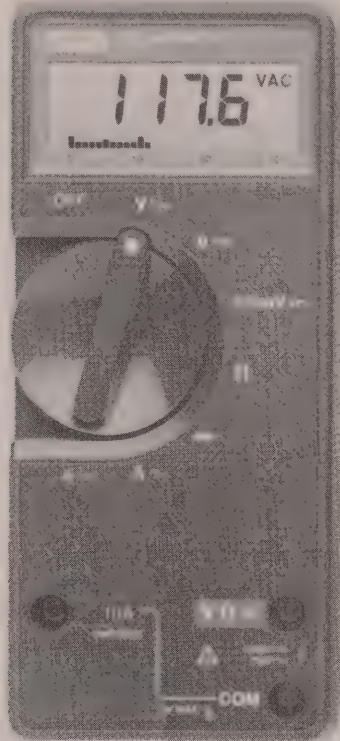
(4) Use Peak-Hold Mode

For other multimeters see page 1.

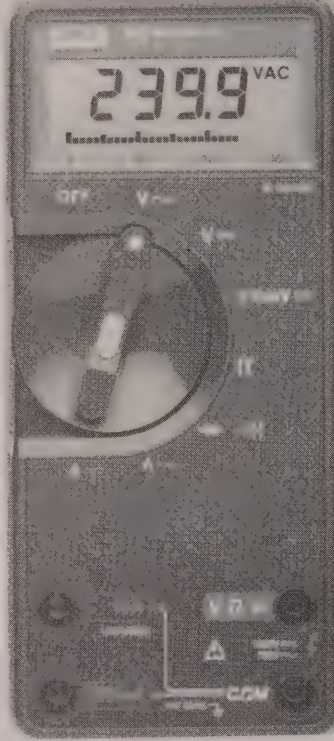


# HANDHELD MULTIMETERS

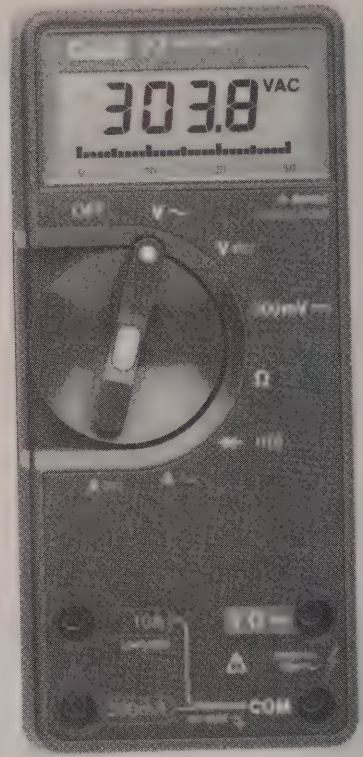
Fluke 73/75/77 Analog/Digital Multimeters . . . Available through Distributors (See page 248)



Fluke 73



Fluke 75



Fluke 77

## The Fluke 73

- 3½ digit, 3200 count display
- 32 segment analog bar graph
- 0.7% basic dc accuracy
- Single rotary switch control
- Autoranging selection
- 2000 hours on a single 9-volt battery
- One current range: 10A
- "Sleep Mode" if battery not switched off
- Tough textured case resists grime
- 3 year warranty, 1-year calibration cycle
- UL 1244 listed, VDE listed

## The Fluke 75

- 3½ digit, 3200 count display
- 32 segment analog bar graph
- 0.5% basic dc accuracy
- Single rotary switch control
- Autoranging selection
- 2000 hours on a single 9-volt battery
- Three current ranges: 10A, 320 mA, and 32 mA (ideal for 4-20 mA current measurements)
- "Sleep Mode" if battery not switched off
- Tough textured case resists grime
- 3 year warranty, 1-year calibration cycle
- UL 1244 listed, VDE listed

### Plus

- Continuity beeper
- "Range Hold" manual range selection

## The Fluke 77

- 3½ digit, 3200 count display
- 32 segment analog bar graph
- 0.3% basic dc accuracy
- Single rotary switch control
- Autoranging selection
- 2000 hours on a single 9-volt battery
- Three current ranges: 10A, 320 mA, 32 mA
- "Sleep Mode" if battery not switched off
- Tough textured case resists grime
- 3 year warranty, 1-year calibration cycle
- UL 1244 listed, VDE listed

### Plus

- "Touch Hold" (patent pending) to capture readings
- Multipurpose protective holster
- Continuity beeper
- Range Hold

# HANDHELD MULTIMETERS

Available through Distributors (See page 248) . . . **Fluke 73/75/77**

These digital multimeters with analog bar graph display utilize the latest advances in microcircuit technology without compromising quality or capability. The result is a series of meters with features never before found, not even on expensive instruments.

## Digital/Analog

The Model 73, 75, and 77 provide a 3200 count digital display that gives extended resolution, and a 32 segment bar graph that reacts 10 times faster than the numerical display, allowing you to make peaking and dipping adjustments easier than with digital-only DMMs.

## Autoranging

With autoranging, you choose the function you want and the meter automatically selects the range with the greatest accuracy and resolution. Symbols on the liquid crystal display remind you what is being measured and the range of measurement.

## Range Hold

Since repetitive go-no-go tests and peaking/dipping adjustments are more easily done using one range, the manual range function will prove a real boon to users making these tests frequently. Touching the pushbutton once prevents the meter from changing ranges. Pushing the button again changes the range, and holding the button down for a couple of seconds restores the "Autorange" function.

## Audible Tones

A continuous audible tone provides a fast check for continuity of current paths having 150 ohms or less.

A brief tone indicates a voltage drop of about 0.6 volts, the normal forward bias for semiconductor devices passing about 500 micro Amps.

## Touch Hold

"Touch Hold" captures a reading and displays it from memory even after the probe has been removed from the circuit. As soon as the reading stabilizes, the meter makes a distinctive audible chirp and automatically holds the reading. "Touch Hold" reduces the chance of circuit damage when a probe slips and contacts two points at once because you can concentrate on touching the right test point and nothing else. "Touch Hold" reduces the risk of electrical shock and also gives the user time to log the reading if needed or refer back to the reading before the next measurement.

## Multipurpose Holster

Our multipurpose holster is made of a tough resilient plastic that snaps over the instrument, protecting it from even the most severe shock. Both test leads may be snapped into the holster in a position so only one hand is needed to hold both the meter and probe tip in contact with the test point. You can also hang the meter on your belt, tilt it back on its bail for bench use, or use the neck strap and belt clip for easy viewing while probing.

## Specifications

Accuracy specifications apply for 1 year after purchase or recalibration when operated in a temperature of 18°C to 28°C and a relative humidity of up to 90% (80% for 32 MΩ resistance range) unless otherwise noted.

### DC Voltage

Range	Resolution	Accuracy: $\pm$ (% of Rdg + Digits)		
		73	75	77
320 mV	0.1 mV			
3.2V	1 mV			
32V	10 mV	0.7% + 1	0.5% + 1	0.3% + 1
320V	100 mV			
1000V	1V	0.8% + 1	0.6% + 1	0.4% + 1

Input Resistance: 10 MΩ

Normal Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz

Common Mode Noise Rejection:  $\geq 120$  dB for dc, 50 Hz, and 60 Hz

Overload Protection: 500V dc or rms ac for 320 mV range and 1000V dc or 750V rms ac for other ranges

Response Time:  $\leq 1$  second to rated accuracy

### AC Voltage (Average-Sensing, RMS-Indicating)

Range	Resolution	Accuracy: $\pm$ (% of Rdg + Digits)		
		73	75	77
3.2V	1 mV	3% + 2*	2% + 2*	2% + 2*
32V	10 mV			
320V	100 mV	3% + 2**	2% + 2**	2% + 2**
750V	1V			

\* 45 Hz to 500 Hz

\*\* 45 Hz to 1 kHz

Typical frequency response is -0.5 dB at 10 kHz on the 32V and 320V ranges and  $\pm 3$  dB at 5 kHz on the 3.2V and 750V range.

Input Impedance: 10 MΩ and  $\leq 50$  pF on all ranges

Common Mode Noise Rejection:  $\geq 60$  dB dc to 60 Hz, 1 kΩ unbalance

Overload Protection: 1000V dc, 750V rms ac

Response Time:  $\leq 2$  seconds to rated accuracy

### DC Current

Range	Resolution	Accuracy: $\pm$ (% of Rdg + Digits)		
		73	75	77
32 mA	0.01 mA	—	1.5% + 2	1.5% + 2
320 mA	0.1 mA	—	2% + 2	2% + 2
10A	10 mA	2% + 2	1.5% + 2	1.5% + 2

Voltage Burden: 0.2V on 32 mA range, 2.0V max. on 320 mA range, 0.5V on 10A range

Input Protection: 630 mA/250V fuse in series with 3A/600V fuse in 300 mA input; 10A input unfused

Response Time:  $\leq 1$  second to rated accuracy

### AC Current (Average-Sensing, RMS-Indicating)

Range	Resolution	Accuracy: $\pm$ (% of Rdg + Digits)*		
		73	75	77
32 mA	0.01 mA	—		
320 mA	0.1 mA	—	3% + 2	3% + 2
10A	10 mA	3% + 2		

\*45 Hz to 1 kHz

Voltage Burden: 0.16V on 32 mA range, 2.0V on 320 mA range, 0.5V on 10A range

Input Protection: 0.63A/250V fuse in series with 3A/600V fuse in the 300 mA input; 10A input unfused

Response Time:  $\leq 2$  seconds to rated accuracy



# HANDHELD MULTIMETERS

**Fluke 73/75/77. . . Available through Distributors (See page 248)**

## Resistance

Range	Resolution	Accuracy: $\pm$ (% of Rdg + Digits)		
		73	75	77
320 $\Omega$	0.1 $\Omega$	1% + 2	0.7% + 2	0.5% + 2
3200 $\Omega$	1 $\Omega$	1% + 1	0.7% + 1	0.5% + 1
32 k $\Omega$	10 $\Omega$			
320 k $\Omega$	100 $\Omega$			
3.2 M $\Omega$	1 k $\Omega$	3% + 1	2.5% + 1	2.0% + 1
32 M $\Omega$	10 k $\Omega$			

**Open Circuit Voltage:**  $\leq 3V$

**Full Scale Voltage:**  $\leq 440$  mV on all ranges except  $\leq 1.4V$  on 32 M $\Omega$  range

**Input Protection:** 500V dc or rms ac

**Response Time:**  $\leq 1s$  up to 320 k $\Omega$ ,  $\leq 2s$  up to 3.2 M $\Omega$ ,  $\leq 10s$  up to 32 M $\Omega$  to rated accuracy

## Continuity

**Threshold:** Approximately 150 ohms

**Audible Tone:** Continuous tone for continuity. Fluke 75 and 77 only.

**Display:** Less than .100 indicates continuity, OL (overload) indicates open-circuit, approximately 20,000 ohms or higher.

**Response Time:** Approximately 100 ms

## Diode Test

**Test Current:** Approximately 500  $\mu A$  for a normal forward biased diode

**Audible Tone:** Brief tone for normal forward biased diode or semiconductor junction. Fluke 75 and 77 only.

**Display:** An indication of approximately .600V for a normal forward biased silicon diode or semiconductor function and OL (overload) for a normal reverse biased diode or semiconductor junction

**Response Time:** Approximately 100 ms

## Analog Display

**Measurement Rate:** 23 measurements per second

## "Touch-Hold"

Fluke 77 only. Pushbutton activated mode. Automatically holds stable reading of voltage, resistance, or current indefinitely even if test probe is removed. Reading updated by touching probe to other test points.

## General Specifications

**Max Common Mode Voltage:** 1000V dc or peak ac

**Temperature:** 0°C to 50°C operating; -40°C to 60°C non-operating

**Temperature Coefficient:** 0.1 x specified accuracy per °C from 18°C to 0°C or 28°C to 50°C

**Relative Humidity:**  $\leq 70\%$  to 50°C,  $\leq 90\%$  to 35°C except  $\leq 80\%$  using 32 M $\Omega$  range

**Safety Rating:** Protection Class II per IEC 348, UL and VDE

**Power:** Single 9V battery, NEDA 1604 9V

**Battery Life:** More than 2000 hours (alkaline) or 1600 hours (carbon-zinc). "Sleep Mode" extends battery life when you forget to turn power off. Sleep mode activates after approximately 1 hour (15 min in diode test)

**Size:** 166 mm L x 75 mm W x 28 mm H (6.55 in x 2.95 in x 1.12 in)

**Weight:** 0.28 kg (0.63 lb)

**Included:** TL 70 Test Leads, manual, warranty card, plus battery and spare fuse (installed). Also C70 Holster included with Fluke 77.

## Models

January 1985 prices

Fluke 73 DMM w/3-year warranty ..... \$85

Fluke 75 DMM w/beeper, w/3-year warranty ..... 99

Fluke 77\* DMM w/Touch-Hold, w/3-year warranty ..... 129

\*Includes C70 Multipurpose Holster

## Accessories (Also see page 55)

C70 Multipurpose Holster ..... 9

C71 Softcase ..... 9

TL70 Replacement Test Leads ..... 5

Y8134 Deluxe Test Lead Kit ..... 20

83RF RF Probe ..... 49

85RF RF Probe ..... 85

80K-6 HV Probe ..... 45

80K-40 HV Probe ..... 80

Y8101\* AC Current Probe ..... 59

80i-400\* AC Current Probe ..... 69

80i-600\* AC Current Probe ..... 99

Y8100 DC/AC Current Probe ..... 199

80J-10 Current Shunt ..... 30

80T-150C Temperature Probe (°C) ..... 120

80T-150F Temperature Probe (°F) ..... 120

\*Not applicable to Fluke 73

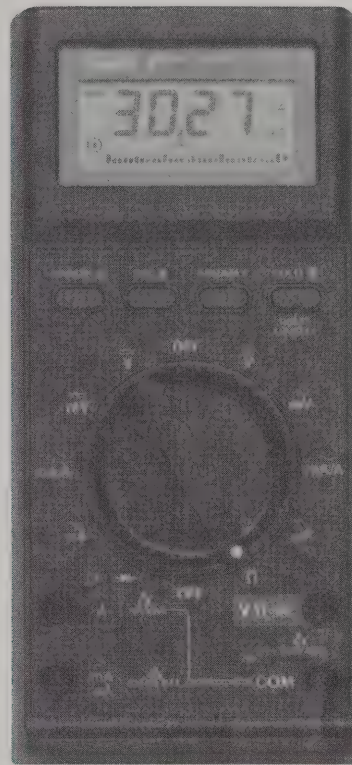
# HANDHELD MULTIMETERS

Available through Distributors (See page 248) . . . Fluke 25/27



Fluke 25 STD

**NEW**



Fluke 27 STD

## Fluke 25 & 27 Analog/Digital & Rugged

- 0.1% basic dc accuracy and 30 kHz ac response
- 3½-digit, 3200 count display
- 31 segment bar graph for peaking, nulling, capacitor checking, and other changing signals
- Auto or manual range selection
- "Touch Hold" to capture and display readings
- Tests insulation resistance to over 10,000 MΩ
- 1000 hour battery life
- Continuity beeper
- LCD symbols annunciate range and modes
- Overload protection including a fused 10A input
- 2 year warranty
- Rugged "O" ring sealed case withstands harsh environments
- Separate sealed battery/fuse door gives easy access
- Superior EMI shielding
- -15° to 55°C operating range
- "Min-Max" Mode stores highest and lowest readings (27 only)
- "Relative Mode" displays only changes in readings (27 only)

## Rugged

Plant maintenance electricians, field service technicians, electrical equipment installers, and outside equipment installers will find these instruments rugged, reliable, and easy to use while providing all the accuracy and features needed for almost any application.

Designed to meet military specifications of MIL-STD28800 for Style A Class 2 Instruments, the Fluke 25 and 27 third generation Analog/Digital Multimeters perform under the extremes of heat, cold, humidity, shock, electromagnetic interference, vibration, and downright abuse.

The Fluke 25 and 27 are built with cases twice as thick as any other DMM we build. The cases are waterproof to 3 feet of water for one hour, resist many industrial chemicals, and won't sustain a flame when put to the blow torch test.

## Safe

Electrical and safety protection exceeds the world's toughest safety standards.

## Autorangeing

With autorangeing, you choose the function you want and the meter automatically selects the range with the greatest accuracy and resolution. Symbols on the liquid crystal display remind you what is being measured and the range of measurement.



# HANDHELD MULTIMETERS

Fluke 25/27... Available through Distributors (See page 248)

## Manual Range

Since repetitive go-no-go tests and peaking/dipping adjustments are more easily done using one range, the manual range function will prove a real boon to users making these tests frequently. Touching the pushbutton once prevents the meter from changing ranges. Pushing the button again changes the range, and holding the button down for a couple of seconds restores the "Autorange" function.

## Audible Tones

A continuous audible tone provides a fast check for continuity of current paths having 150 ohms or less.

A brief tone indicates a voltage drop of about 0.6 volts, the normal forward bias for semiconductor devices.

## Touch Hold

"Touch Hold" captures a reading and displays it from memory even after the probe has been removed from the circuit. As soon as the reading stabilizes, the meter makes a distinctive audible chirp and holds the reading. "Touch Hold" reduces the chance of circuit damage when a probe slips and contacts two points at once because you can concentrate on touching the right test point and nothing else. "Touch Hold" reduces the risk of electrical shock and also gives the user time to log the reading if needed or refer back to the reading before the next measurement.

## Min/Max Mode

The 27 can be connected to record minimum and maximum values that will be stored in memory for an extended period, such as over a weekend: useful for monitoring in the absence of chart recorders.

## Relative Mode

Often a technician will need to know how much one reading differs from another. By taking the first reading as a reference then pressing the "REL" button, the succeeding measurements will display only the deviation from the reference.

## Specifications

### DC Voltage

Range	Resolution	Accuracy: ±(% of Rdg + Digits)
3.200V	0.001V	0.1% + 1
32.00V	0.01V	
320.0V	0.1V	
1000V	1V	
320.0 mV	0.1 mV	0.1% + 1

Input Impedance: 10 MΩ in parallel with <100 pF

Normal Mode Noise Rejection: >60 dB at 50 Hz or 60 Hz

Common Mode Noise Rejection: >120 dB at dc, 50 Hz or 60 Hz; ≤1 kΩ unbalance

Overload Protection V: 1000V rms

Overload Protection mV: 500V rms

### AC Voltage

Range	Resolution	Accuracy: ±(% of Rdg & Digits)		
		40 Hz-2 kHz	2 kHz-10 kHz	10 kHz-30 kHz
3.200V	0.001V	0.5% + 3	2% + 3	4% + 10
32.00V	0.01V			
320.0V	0.1V			
1000V	1V	1% + 3	3% + 3	Not spec'd.
320.0 mV	0.1 mV	0.5% + 3	2% + 3	4% + 10

Input Impedance: 10 MΩ in parallel with <100 pF (ac coupled)

Common Mode Noise Rejection: >60 dB from dc to 60 Hz; ≤1 kΩ unbalance

Overload Protection V ac: 1000V rms (10<sup>7</sup> volt-hertz max)

Overload Protection mV ac: 500V rms (10<sup>7</sup> volt-hertz max)

### DC Current

Range	Resolution	Accuracy ±(% of Rdg + Digits)	Typical Burden Voltage
32.00 mA	0.01 mA	0.75% + 2	0.18V
320.0 mA	0.1 mA		1.8V
10.00A	0.01A		0.5V
320.0 μA	0.1 μA	0.75% + 2	0.16V
3200 μA	1 μA		1.6V

Input Protection: μA/mA ranges, 630 mA/250V fuse in series with 3A/600V fuse; 10 amp range, 20A/600V fuse

### AC Current

Range	Resolution	Accuracy: ±(% of Rdg + Digits)	Typical Burden Voltage
32.00 mA	0.01 mA	1.5% + 2	0.18V
320.0 mA	0.1 mA		1.8V
10.00A	0.01A		0.5V
320.0 μA	0.1 μA	1.5% + 2	0.16V
3200 μA	1 μA		1.6V

Overload Protection: Same as DC Current

### Resistance

Range	Resolution	Accuracy ±(% of Rdg + Digits)
320.0Ω	0.1Ω	0.3% + 2
3.200 kΩ	0.001 kΩ	0.2% + 1
32.00 kΩ	0.01 kΩ	
320.0 kΩ	0.1 kΩ	
3.200 MΩ	0.001 MΩ	
32.00 MΩ	0.01 MΩ	1% + 1

Overload Protection: 500V rms

Open Circuit Test Voltage: <2.8V dc

Full Scale Voltage: Up to 3.2 MΩ <420 mV dc; 32 MΩ <1.3V dc

Conductance: Measures up to 32.00 nS with 0.01 nS resolution accurate to ±1% + 10; full scale voltage <1.3V dc

### Diode Test/Continuity Test

Overload Protection	Open Circuit Test Voltage	Typical Test Current	Display Voltage
500V rms	<3.3V dc	0.7 mA	0.0V
		0.5 mA	0.6V
		0.3 mA	1.2V
		0.1 mA	2.0V

## General Specifications

MIN/MAX Mode (27 only): Records the digital display readings (updated twice per second)

Display: 3½ digits 3200 counts autopolarity, autozero

Common Mode Voltage: 1000V between any terminal and earth ground

Shock, Vibration and Water Resistance: Per MIL-T-28800 Class 2 Style A

Temperature: Storage -55°C to 85°C; Operation -15°C to 55°C

Temperature Coefficient: 0.1 x (specified accuracy) per °C for temperatures <18°C or >28°C

Relative Humidity: 0% to 95% (0°C to 35°C); 0% to 70% (35°C to 55°C)

Power: Single 9V NEDA 1604 or 6F22 or 006P

Battery Life: >1000 hours typical

Battery Indicator: Symbol first displayed when 60 hours of life remain

Safety: Protection Class II per IEC 348 and ANSI C39.5

Size: 2.2 in H x 3.75 in. W x 8 in L (56 mm x 95 mm x 203 mm)

# HANDHELD MULTIMETERS

Available through Distributors (See page 248) . . . **Fluke 25/27**

**Weight:** 1.6 lb (0.75 kg)

**C20 Case Size:** 4 in. H x 6 in. W x 10.3 in L. (102mm H x 152mm W x 262mm L)

**Note:** Case is 13 in. (330mm) L including handle

**Warranty:** 2 years; calibration guaranteed for one year

**Includes:** Battery, TL70 Test Leads, two insulated alligator clips, spare fuse, and Operator's manual

Available in dark umber (STD model) or yellow (YEL model).



## Models

January 1985 prices

Fluke 25 STD Multimeter .....	\$229
Fluke 25 YEL Multimeter .....	229
Fluke 27 STD Multimeter .....	259
Fluke 27 YEL Multimeter .....	259

## Accessories (Also see page 55)

C20 Hard Case .....	20
C25 Soft Case .....	15
TL70 Replacement Test Leads .....	5
Y8134 Deluxe Test Lead Kit .....	20
83RF 100 MHz RF Probe .....	49
85RF 500 MHz RF Probe .....	85
80K-6 High Voltage Probe .....	45
80K-40 High Voltage Probe .....	80
Y8101 AC Current Probe .....	59
80i-400 AC Current Probe .....	69
80i-600 AC Current Probe .....	99
Y8100 DC/AC Current Probe .....	199
80J-10 Current Shunt .....	30
80T-150C Temperature Probe, °C .....	120
80T-150F Temperature Probe, °F .....	120

## After-Warranty Service (See page 227)

SC1-25, per 90-day interval .....	21
SC1-27, per 90-day interval .....	22



# HANDHELD MULTIMETER

8025A

NEW



8025A

## 8025A Multimeter NSN 6625-01-147-6182

- Designed for MIL-T-28800 Type II, Class 2, Style A requirements
- 3½-digit, 3200 count display
- 31 segment bar graph for peaking, nulling, capacitor checking, and other changing signals
- 0.2% basic dc accuracy
- "Touch Hold" to capture and display readings
- LCD symbols annunciate range and modes
- Safety designed with extensive overload protection, non-metallic case, recessed input jacks
- Rugged sealed construction keeps out dirt, water, and contaminants
- Comes with C20 Ruggedized Hard Case and test leads
- 1000 hour battery life
- One year calibration interval
- Two year warranty
- Fast autoranging or manual ranging
- Range hold
- Continuity/diode test beeper

Designed for use in harsh military environments, the 8025A offers the performance and accuracy of a digital multimeter with the speed

and dynamic measurement capability of an analog meter. Available through Fluke Sales Offices (see page 243 for listing), the 8025A offers bench instrument performance in a convenient hand-held package.

### 3200-Count Digital Display

The 8025A 3½-digit (3200 count) display equals the resolution of a 4½-digit meter for readings between 2 and 3.2, 20 and 32, or 2000 and 3200.

The analog bar graph allows quicker, easier testing for erratic or unstable signals. It updates ten times faster than the digital display.

### Autoranging

Simplifies and speeds up the use of the meter. No need to decide what range to use or to wait for long range-changing delays. Manual ranging is also included.

### Audible Continuity/Diode Test

Wiring, diode, and transistor checks can be done quickly without looking at the display.

### Touch Hold

You can take readings of critical circuitry while keeping your eyes on the probes and circuit. Using standard test leads, the 8025A captures your measurement, beeps, locks the reading in the display for viewing, and then automatically updates when a new measurement is taken.

### Safety

Safety is designed in with extensive overload protection, high energy fuses, fused 10A range, non-metallic case and bail, recessed input jacks, safety-designed test leads, and no fuses to replace for voltage and resistance overloads.

### Low Power Resistance

In-circuit resistance measurements can be made without turning on diodes or transistors.

## Specifications

Basic electrical specifications are defined for the temperature range of 18°C to 28°C and relative humidity up to 95%, for one year after calibration.

### Display

#### Liquid crystal

**Digital Display:** 3200 counts plus polarity indication, updated 2 times per second

**Analog Display:** 31 segment bar graph plus polarity indication, updated 25 times per second

**Annunciators:** k, M,  $\Omega$  (Ohms); (Hold); (low battery); (manual range); 3, 30, 300 (range indicators); nS (nanosiemens)

### DC Voltage

Range	Resolution	Accuracy: $\pm$ (% of Rdg + Digits)
320.0 mV	100 $\mu$ V	0.2% + 1
3.200V	1 mV	
32.00V	10 mV	
320.0V	100 mV	
1000V	1V	

**Input Impedance:** 10 M $\Omega$  nominal

**Normal Mode Noise Rejection:** >60 dB at 50 Hz and 60 Hz

**Common Mode Noise Rejection:** >120 dB at dc, 50 Hz and 60 Hz;  $\leq 1$  k $\Omega$  unbalance

**Overload Protection:** 1000V rms; 500V rms on 320 mV range

## AC Voltage

Range	Resolution	Accuracy: $\pm$ (% of Rdg & Digits)		
		40 Hz-2 kHz	2 kHz-10 kHz	10 kHz-30 kHz
320.0 mV	100 $\mu$ V	0.5% + 3	2% + 3	4% + 10
3.200V	1 mV			
32.00V	10 mV			
320.0V	100 mV			
1000V	1V	1% + 3	3% + 3	Not spec'd.

**Conversion Type:** AC coupled, average sensing, calibrated to read rms value of sinewave

**Input Impedance:** 10 M $\Omega$  nominal in parallel with <100 pF

**Common Mode Rejection Ratio:** >60 dB, DC to 50 Hz,  $\leq 1$  k $\Omega$  unbalance

**Overload Protection:** 1000V rms, 500V rms on 320 mV range;  $10^7$  volt-hertz maximum

## DC and AC Current

Range	Resolution	Typical Burden Voltage	Accuracy: $\pm$ (% of Rdg + Digits)	
			DC Accuracy	AC Accuracy 40 Hz to 1 kHz
320.0 $\mu$ A	0.1 $\mu$ A	160 mV	0.75% + 2	1.5% + 2
3200 $\mu$ A	1 $\mu$ A	1.6V		
32.00 mA	10 $\mu$ A	180 mV		
320.0 mA	100 $\mu$ A	1.8V		
10.00A	10 mA	0.5V		

**Overload Protection:**  $\mu$ A/mA ranges: 630 mA/250V fuse in series with 3A/600V fuse. Amp range: 20A/600V fuse

## Resistance

Range	Resolution	Accuracy $\pm$ (% of Rdg & Digits)
320.0 $\Omega$	0.1 $\Omega$	0.3% + 2
3.200k	1 $\Omega$	0.2% + 1
32.00k	10 $\Omega$	
320.0k	100 $\Omega$	
3.200M	1 k $\Omega$	
32.00M	10 k $\Omega$	1% + 1
32.00 nS	0.01 nS	2% + 10

**Overload Protection:** 500V rms

**Full Scale Voltage:** <420 mV up to 3.2 M $\Omega$ ; <1.3V up to 32 M $\Omega$

**Open Circuit Voltage:** <2.8V (-15°C to 55°C)

## Diode Test and Continuity:

**Diode Test Indication:** Displays voltage drop; 0.5 mA nominal test current at 0.6V; 2.08V full scale

**Continuity Indication:** Continuous audible tone for test resistance below 150 ohms. Momentary tone for test voltage dropping below 0.7V (typical silicon diode threshold)

**Open Circuit Voltage:** <3.3V (-15°C to 55°C)

**Overload Protection:** 500V rms

## General Specifications

**Maximum Voltage to be applied to any terminal:** 1000V with respect to earth ground

**Power Requirements:** Single 9V battery NEDA 1604

**Battery Life:** 1000 hours typical. Battery symbol first displayed when at least 60 hours of battery life remain

**Instrument Size:** 56mm H x 95mm W x 203mm L (2.2 in H x 3.75 in W x 8 in L)

**C20 Case Size:** 102mm H x 152mm W x 262mm L (4 in H x 6 in W x 10.3 L

**Note:** Case is 330mm L (13 in) including handle

**Weight:** 8025A alone is 0.75 kg (1.6 lb) with case and accessories 1.5 kg (3.2 lb)

**Storage Temperature:** -55°C to 85°C

**Operating Temperature:** -15°C to 55°C; operates to -40°C for 20 minutes when taken from a 20°C environment

**Temperature Coefficient:** 0.1 x the applicable accuracy specification per °C (for temperatures <18°C or >28°C)

**Shock, Vibration, Humidity and Water Resistance:** Per MIL-T-28800 for a Style A, Class 2 instrument

**Included:** Battery, TL70 Test Leads, two insulated alligator clips, Instruction Manual, and C20 Ruggedized Hard Case (includes operator's decal)

## Model

January 1985 prices

8025A NSN 6625-01-147-6182 Multimeter ..... \$279

## Accessories (Also see page 55)

C25 Soft Case .....	15
TL70 Replacement Test Leads .....	5
Y8134 Deluxe Test Lead Kit .....	20
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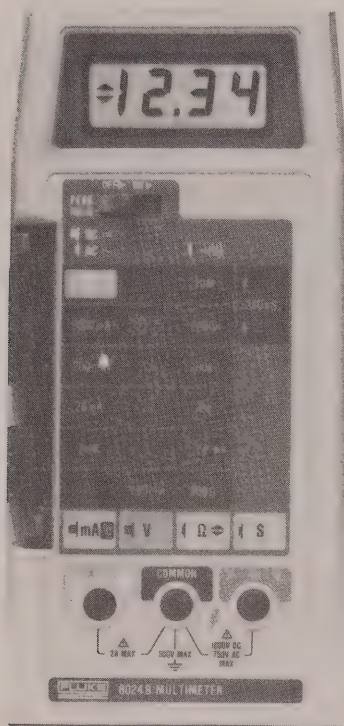
## After-Warranty Service (See page 227)

SC1-8025, per 90-day interval ..... 21



# HANDHELD MULTIMETER

8024B... Available through Distributors (See page 248)



8024B

## 8024B More Than a DMM

- 3½ digits (2000 counts)
- High speed audible continuity (50  $\mu$ s response)
- Peak-Hold
- Temperature (with any K-type thermocouple)
- Logic level detection
- Conductance
- 0.1% basic dc accuracy
- 2-year warranty, 2-year calibration cycle
- Full overload protection
- Fast ac or dc transient capture
- Shock and vibration per MIL-T-28800, Class 5
- Tilt bail with detent position
- UL 1244 listed

Designed with the field service technician in mind, this instrument provides a unique combination of functions that reduces the number of tools needed for on-location repairs. Temperature capability (use any K thermocouple), peak-hold (measure motor starting currents or line transients), and a logic level indicator in combination with features more commonly found on DMMs will make this multimeter an integral part of any customer service tool kit.

The 8024B, like all Fluke handheld DMMs, will withstand the rigors of field service. It is used around the world by people who demand exceptional performance, reliability, and ruggedness.

## Continuity Tests

The 8024B indicates circuit continuity in two ways, using either the conductance or resistance ranges. The LCD display shows a  $\blacktriangle$  symbol for an open and  $\blacktriangledown$  for continuity. Also, an audible "beep" will sound when continuity is detected — useful when you cannot see the

LCD display. Both types of indicators use a pulse-stretcher circuit so that even momentary shorts or opens as brief as 50 microseconds can be detected.

## Peak-Hold

This function works for dc or ac voltage or current measurements and is for capturing transient dc peaks or ac surges. For dc, the most positive value will be displayed on the LCD, and peaks typically as short as 2 ms are captured. Average-sensing, rms-indicating techniques are used for ac for transients as short as 150 ms for 48 to 450 Hz waveforms. The decay-rate of the display is less than one digit per second.

This feature is especially useful for measuring voltage pulses in electro-mechanical equipment or surge currents in electric motors. Currents as high as 600 amps may be measured using the optional current transformer 80i-600 clamp-on ac current probe.

## Temperature

The 8024B directly displays temperature (in degrees Celsius) when used with optional K-type thermocouples. The input of the 8024B has a temperature-compensated reference junction.

Temperatures from  $-20^{\circ}\text{C}$  to  $+1265^{\circ}\text{C}$  can be measured depending on the K-type thermocouple used. The Y8102 is a sheathed probe, good to  $+925^{\circ}\text{C}$ , for liquid immersion or penetration measurements. The Y8103 is a bead thermocouple, good to  $+260^{\circ}\text{C}$ , for air or gas temperature measurements. The Y8104 is a termination kit for attaching any K-type thermocouple to the 8024B.

Now you can measure component heat rise, motor temperatures, heating and cooling equipment, etc.

Fluke's high-resolution semiconductor temperature probes, the 80T-150C and the 80T-150F, will also work with the 8024B as well as all other Fluke DMMs. They have better resolution and accuracy but cover a smaller temperature range (to  $+150^{\circ}\text{C}$  or  $+302^{\circ}\text{F}$ ). The 80T-150's are suited for surface, air, and some liquid immersions.

## Logic Level Detection

This function serves the same purpose as an oscilloscope or logic probe in detecting level transitions that last 50 microseconds or longer.

A pulse stretcher is used to detect low-duty-cycle pulses.

AUDIBLE TONE	)  ) ) )  ) ) )  ) ) )  ) ) )
DISPLAY	$\blacktriangle$ $\blacktriangledown$ $\blacktriangledown$ $\blacktriangledown$ $\blacktriangledown$
TYPICAL INPUT SIGNALS	

## Conductance

This unique Fluke feature enables the user to make high resistance measurements, up to 10,000 M $\Omega$ . Conductance is useful for testing high value resistors, leakage in cables, diodes, printed circuit boards, and connectors.

## Other Features

Fluke engineers have designed extensive protective circuitry into the 8024B so that it will not be damaged by accidental overloads or operator errors.

The 8024B has a 2-year calibration cycle and is covered by a 2-year

# HANDHELD MULTIMETER

Available through Distributors (See page 248) . . . 8024B

warranty on parts and labor. If service is required, there are Fluke authorized service centers around the world to help you.

You can expand the measurement capabilities of the 8024B with optional accessories.

## Specifications

All accuracy specifications apply for two years after purchase or recalibration when operated in a temperature of 18°C to 28°C and a relative humidity of up to 90%, unless otherwise noted.

### DC Voltage

Range	Resolution	Accuracy
200 mV	100 $\mu$ V	$\pm(0.1\%$ of reading + 1 digit)
2V	1 mV	
20V	10 mV	
200V	0.1V	
1000V	1V	

**Input Impedance:** 10 M $\Omega$  on all ranges

**Normal Mode Noise Rejection:**  $\geq 60$  dB at 50 and 60 Hz

**Common Mode Noise Rejection:** 100 dB at dc, 50 Hz, and 60 Hz with 1 k $\Omega$  unbalance

**Overload Protection:** 1000V dc or peak ac on all ranges except 15 seconds max on 200 mV range above 300V dc or rms ac

**Response Time:**  $\leq 1$ s, all ranges

### AC Voltage (Average-Sensing, RMS-Indicating)

Range	Resolution	Accuracy: $\pm(\%$ of Rdg + Digits)		
		45 Hz to 1 kHz	1 kHz to 2 kHz	2 kHz to 5 kHz
200 mV	100 $\mu$ V	0.75% + 2	1.5% + 3	5% + 5
2V	1 mV			
20V	10 mV			
200V	100 mV	1% + 2	Not Specified	
750V	1V			

**Conversion:** Calibrated for rms value of sinewaves

**Input Impedance:** 10 M $\Omega$  on all ranges,  $\leq 100$  pF

**Common Mode Noise Rejection:**  $> 60$  dB at 50 Hz, 60 Hz, 1 k $\Omega$  unbalance

**Overload Protection:** 1000V dc or 750V rms on all ranges except 200 mV ac range is 15 seconds maximum above 300V ac

**Response Time:**  $\leq 2$ s, all ranges

### Resistance

Range	Resolution	Accuracy $\pm(\%$ of Rdg + Digits)	Full-Scale Voltage	Max Test Current
200 $\Omega$	0.1 $\Omega$	0.2% + 3	$\leq 0.25$ V	0.35 mA
2 k $\Omega$ *	1 $\Omega$	0.1% + 1	$\geq 1.0$ V	1.1 mA
20 k $\Omega$	10 $\Omega$		$\leq 0.25$ V	13 $\mu$ A
200 k $\Omega$ *	100 $\Omega$		$\geq 0.7$ V	13 $\mu$ A
2000 k $\Omega$	1 k $\Omega$	0.15% + 1	$\leq 0.25$ V	0.13 $\mu$ A
20 M $\Omega$ *	10 k $\Omega$	2% + 1	$\geq 0.7$ V	0.13 $\mu$ A

\*Diode Test ranges

**Diode Test:** The three diode test ranges are marked with a diode symbol and have enough open circuit voltage to turn on silicon junctions allowing a diode test. The 2 k $\Omega$  range is preferred and is marked with a large diode symbol. The three non-diode test ranges will not turn on silicon junctions when making in-circuit resistance measurements.

**Open Circuit Voltage:** Less than 1.5V on all ranges, except 2 k $\Omega$  range is less than 3.5V

**Input Protection:** 500V dc or rms on all ranges; 15 seconds maximum above 300V dc or rms ac

### Conductance

Conductance is the inverse of ohms ( $1/\Omega$ ) and is expressed in Siemens (S), formerly mhos. A decrease in conductance is the same as an increase in resistance.

Range*	Resolution	Accuracy $\pm(\%$ of Rdg + Digits)	Open Circuit Voltage	Max Test Current
200 nS	0.1 nS	2% + 10	$< 1.5$ V	0.13 $\mu$ A

\*Equivalent to 5 M $\Omega$  to 10,000 M $\Omega$

**Input Protection:** To 500V dc or rms ac; 15 seconds maximum above 300V dc or rms ac

### DC Current

Range	Resolution	Accuracy $\pm(\%$ of Rdg + Digits)	Burden Voltage
2 mA	1 $\mu$ A	0.75% + 1	0.3V max
20 mA	10 $\mu$ A		
200 mA	100 $\mu$ A		
2000 mA	1 mA		0.9V max

**Input Protection:** 2A/250V fuse in series with 3A/600V fuse

**Response Time:**  $\leq 1$  second, all ranges

### AC Current (Average-Sensing, RMS-Indicating)

Range	Resolution	Accuracy $\pm(\%$ of Rdg + Digits)		Burden Voltage (RMS)
		45 Hz to 450 Hz	450 Hz to 1 kHz	
2 mA	1 $\mu$ A	3% + 2	Not Spec'd	0.25V max
20 mA	10 $\mu$ A	1.5% + 2		0.9V max
200 mA	100 $\mu$ A			
2000 mA	1 mA			

**Overload Protection:** 2A/250V and 3A/600V fuse in series

**Response Time:**  $\leq 1$ s, all ranges

### Peak-Hold

**Functions:** Dc or ac voltage, dc or ac current, all ranges

**DC Accuracy:**  $\pm(3\%$  of reading + 10 digits) square positive pulses of  $\geq 10$  ms duration (2 ms typical)

**AC Accuracy:** 48 Hz to 450 Hz,  $\geq 150$  ms surge duration,  $\pm(3\%$  of reading + 10 digits) all ranges, except  $\pm(6\%$  of reading + 10 digits) on 2 mA range. Average-sensing, calibrated to read highest rms value of sinewave

**Display Decay Rate:**  $\leq 1$  digit per second

### Temperature

**Sensor:** K-type thermocouple (optional, not included)

**Range:** -20°C to +1265°C, depending on model of thermocouple

**Resolution:** 1°C

**Accuracy:**  $\pm(3^\circ\text{C} + 1\text{digit})$  from -20°C to  $\pm 300^\circ\text{C}$  and  $\pm 3\%$  of reading from 300°C to 1265°C. Accuracy includes NBS curve conformity, calibration, stability, zero, and reference junction, but excludes thermocouple errors

**Input Connections:** Banana jacks (COMMON and mA  $^\circ\text{C}$ ) which are reference junction temperature compensated. Fluke K-type thermocouples have dual banana plugs. For any other K-type thermocouples or thermocouple wire, use Y8104 terminations

**Overload Protection:** 2A/250V and 3A/600V fuse in series

### Continuity

**Ranges:** Conductance range and all resistance ranges

**Indication:** "▲" for open circuit. "▼" for continuity, plus switch-selectable 2 kHz audio tone



# HANDHELD MULTIMETER

**8024B . . . Available through Distributors (See page 248)**

**Response Time:** (2 k $\Omega$  range) 50  $\mu$ s minimum duration of continuity or open to toggle display and/or audible tone. A pulse-stretcher circuit holds display and produces or interrupts tone for approximately 100 ms when short duration continuity or opens occur  
**Input Protection:** 500V dc or rms ac all ranges; 15 seconds maximum above 300V dc or rms ac

## Level Detection

**Reference Level:** +0.8V dc, nominal

**Display:** "▲" for inputs above reference, "▼" for inputs below reference, both for inputs continually crossing reference level. Switch-selectable audio tone coincident with "▼"

**Pulse Response Time:** (200 k $\Omega$  range)  $\geq$ 50  $\mu$ s for 0 to +3V pulse to toggle display. Pulse stretcher holds display for approximately 100 ms when short pulses are detected

**Input Impedance:**  $\geq$ 100 k $\Omega$ ,  $\leq$ 100 pF

**Overload Protection:** 500V dc or rms ac; 15 seconds maximum above 300V dc or rms ac

## General Specifications

**Display:** 3½ digits (2000 counts), LCD, autozero, autopolarity

**Common Mode Voltage:** 500V dc or rms ac, max

**Shock and Vibration:** Per MIL-T-28800, Class 5

**Temperature:** 0°C to 50°C, operating; -35°C to +60°C, non-operating

**Temperature Coefficient:**  $<0.1 \times$  the applicable accuracy specification, per °C from 18°C to 0°C and 18°C to 50°C, except temperature function is  $<0.02 \times$  accuracy per °C

**Relative Humidity:**  $\leq$ 90% to 35°C, except  $\leq$ 80% to 35°C on 2 M $\Omega$ , 20 M $\Omega$ , and 200 nS ranges;  $\leq$ 70% to 50°C

**Power:** Single 9V battery, NEDA 1604

**Battery Life:** Alkaline, 100 hours typical

**Battery Indicator:** "BT" on display lights when approximately 20% of life remains

**Size:** 180 mm L x 86 mm W x 45 mm H (7.1 in L x 3.4 in W x 1.8 in H)

**Weight:** 0.48 kg (1.05 lb)

**Included:** Manual, test leads (Y8132), 9V battery, operator's card, spare fuse, Statement of Calibration Practice

## Model

January 1985 prices

8024B DMM . . . . . \$249

## Accessories (Also see page 55)

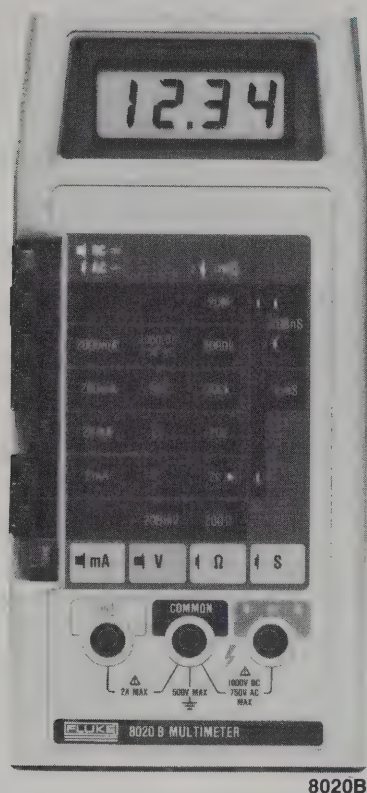
Y8132 Replacement Test Leads . . . . .	10
Y8134 Deluxe Test Lead Set . . . . .	20
Y8140 Slim Test Leads, w/needle points . . . . .	18
80K-6 High Voltage Probe . . . . .	45
80K-40 High Voltage Probe . . . . .	80
83RF 100 MHz RF Probe . . . . .	49
85RF 500 MHz RF Probe . . . . .	85
80T-150C Temperature Probe, °C . . . . .	120
80T-150F Temperature Probe, °F . . . . .	120
Y8102 Sheathed Thermocouple . . . . .	60
Y8103 Bead Thermocouple . . . . .	25
Y8104 Thermocouple Termination . . . . .	10
80T-SP Thermocouple Surface Temperature Probe . . . . .	95
80i-400 AC Current Probe . . . . .	69
80i-600 AC Current Probe . . . . .	99
Y8100 DC/AC Current Probe . . . . .	199
Y8101 AC Current Probe . . . . .	59
A81 Battery Charger/Eliminator . . . . .	20
C90 Carrying Case . . . . .	10
Y8105 Ruggedized Carrying Case . . . . .	20

## After-Warranty Service (See page 227)

SC1-8024B, per 90-day interval . . . . . 18

# HANDHELD MULTIMETERS

Available through Distributors (See page 248) . . . 8026B/8020B



8020B

## 8026B and 8020B Professional Precision

- 3½ digits (2000 counts)
- All basic DMM functions
- Conductance
- Diode Test
- True rms (8026B only)
- 0.1% basic dc accuracy
- High-speed audible continuity testing (beeper)
- Bail with detent position
- Extensive overload protection
- UL 1244 listed
- Shock and vibration per MIL-T-28800, Class 5
- Two year warranty
- Extended measurements with optional accessories

Both the 8026B and 8020B provide features that make them ideal for troubleshooting relays, cables, switches, and for locating intermittent shorts and opens. The 8026B and 8020B offer capabilities that allow you to check leakage current of diodes, cable insulation, connectors, printed circuit boards, etc.

The 8026B and 8020B are equipped with extensive internal protection against overloads, transients to 6 kV, or operator errors. The current input is protected with two in-series fuses — 2A/250V and 3A/600V. In normal overload situations, only the common 2A/250V fuse will blow. The 3A/600V fuse will blow when accidentally attached to a source of more than 250 volts — like a 480-volt power line. Over 20% of the components are devoted exclusively to overload protection.

## True RMS

Most ac meters are accurate only when measuring sinewaves. In modern electronic and electrical equipment, however, measurement errors on the order of 20% or more may result from radically non-sinusoidal waveforms such as squarewaves, pulses, or the outputs from silicon controlled rectifiers. True-rms sensing circuits such as found in the 8026B prevent such errors.

## Specifications

All accuracy specifications apply for one year after purchase or recalibration (2 years for 8020B) when operated in a temperature of 18°C to 28°C and a relative humidity of up to 90%, unless otherwise noted.

### DC Voltage

Ranges:  $\pm 200$  mV,  $\pm 2$  V,  $\pm 20$  V,  $\pm 200$  V,  $\pm 1000$  V

Resolution: 100  $\mu$ V on 200 mV range

Accuracy:  $\pm(0.1\%$  of reading + 1 digit), all ranges

Input Impedance: 10 M $\Omega$ , all ranges

Normal Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz

Common Mode Noise Rejection:  $\geq 100$  dB at dc, 50 Hz, and 60 Hz, with  $\leq 1$  k $\Omega$  unbalance

Overload Protection: 1000V dc or peak ac on all ranges, except 15 seconds maximum above 300V rms on 200 mV range

Response Time:  $< 1$  second

### AC Voltage, True-RMS (8026B)

Range	Resolution	Accuracy $\pm(1\%$ of Rdg + Digits)			
		45 Hz to 1 kHz	1 kHz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
200 mV	100 $\mu$ V	0.5% + 2		0.5% + 2	2% + 3
2V	1 mV		0.5% + 2		
20V	10 mV				
200V	0.1V	1% + 2	Not Specified		
750V	1V				

### AC Voltage, Average-Sensing, RMS-Indicating (8020B)

Range	Resolution	Accuracy $\pm(\%$ of Rdg + Digits)		
		45 Hz to 1 kHz	1 kHz to 2 kHz	2 kHz to 5 kHz
200 mV	100 $\mu$ V	0.75% + 2	1.5% + 3	0.5% + 5
2V	1 mV			
20V	10 mV			
200V	0.1V	1% + 2	1% + 2	Not Specified
750V	1V			

Input Impedance: 10 M $\Omega$ ,  $\leq 100$  pF, all ranges

Common Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz, with  $\leq 1$  k $\Omega$  unbalance

Overload Protection: 1000V dc or 750V rms ac, continuous, except 15 seconds maximum above 300V rms on 200 mV range

Response Time:  $< 2$  seconds

### Resistance

Range	Resolution	Accuracy $\pm(\%$ of Rdg + Digits)	Full Scale Voltage	Max Test Current
200 $\Omega$	0.1 $\Omega$	0.2% + 3	$< 0.25$ V	0.35 mA
2 k $\Omega^*$	1 $\Omega$	0.1% + 1	$> 1.0$ V	1.1 mA
20 k $\Omega$	10 $\Omega$		$< 0.25$ V	13 $\mu$ A
200 k $\Omega^*$	100 $\Omega$		$> 0.7$ V	13 $\mu$ A
2000 k $\Omega$	1 k $\Omega$	2% + 1	$< 0.25$ V	0.13 $\mu$ A
20 M $\Omega^*$	10 k $\Omega$		$> 0.7$ V	0.13 $\mu$ A

\*Diode test ranges



# HANDHELD MULTIMETERS

**8026B/8020B . . . Available through Distributors (See page 248)**

**Diode Test:** The three diode test ranges have enough open circuit voltage to turn on silicon junctions allowing a diode test. The 2 k $\Omega$  range is preferred and is marked with a diode symbol. The three other ranges will not turn on silicon junctions when making in-circuit resistance measurements

**Open Circuit Voltage:** Less than 1.5V on all ranges except the 2 k $\Omega$  range is 3.5V or less

**Overload Protection:** 500V dc or rms ac on all ranges, 15 seconds maximum above 300V

## Continuity

**Resistance Ranges:** All. The 2 k $\Omega$  range is recommended for lowest resistance threshold

**Indication:** Audible tone for continuity; no tone for open circuit

**Response Time:** (2 k $\Omega$  range) 50  $\mu$ s minimum duration of continuity or open to toggle tone on or off. A pulse-stretcher circuit produces or interrupts the tone for about 200 ms when a short duration continuity or open occurs

**Overload Protection:** 500V dc or rms ac on all ranges, 15 seconds maximum above 300V

## DC Current

Range	Resolution	Accuracy	Burden Voltage
2 mA	1 $\mu$ A	$\pm(0.75\%$ of reading + 1 digit)	0.25V max
20 mA	10 $\mu$ A		
200 mA	100 $\mu$ A		
2000 mA	1 mA		0.9V max

**Overload Protection:** 2A/250V and 3A/600V fuse in series

## AC Current, True-RMS (8026B) Average-Sensing, RMS-Indicating (802)

Range	Resolution	Accuracy: ±[% of Rdg + Digits]		Burden Voltage
		45 Hz to 450 Hz	450 Hz to 1 kHz	
2 mA	1 μA	3% + 2	Not Spec'd	0.3V rms max
20 mA	10 μA	1.5% + 2		0.9V rms max
200 mA	100 μA			
2000 mA	1 mA			

**Overload Protection:** 2A/250V and 3A/600V fuse in series

## Conductance

Conductance is the inverse of ohms ( $1/\Omega$ ) and is expressed in Siemens (S), formerly mhos. A decrease in conductance is the same as an increase in resistance.

Range	Resolution	Accuracy $\pm(1\%$ of Rdg + Digits)	Open Circuit Voltage	Max Test Current
2 mS	10 $\mu$ S	0.2% + 1	<3.5V	1.1 mA
200 nS	0.1 nS	2% + 10	<1.5V	0.13 $\mu$ A

## Equivalent Resistance

2 mS Range: 500 $\Omega$  to 1 M $\Omega$

200 nS Range: 5 M $\Omega$  to 10,000 M $\Omega$

## General Specifications

**Display:** 3½ digits (2000 counts), LCD, autozero, autopolarity

**Common Mode Voltage:** 500V dc or rms ac, maximum

**Shock and Vibration:** Per MIL-T-28800, Class 5

**Temperature Coefficient:** <0.1 x the applicable accuracy specification per °C from 18°C to 0°C or 28°C to 50°C

**Temperature:** 0°C to 50°C, operating; -35°C to +60°C, non-operating

**Relative Humidity:**  $\leq 90\%$  to 35°C except  $\leq 80\%$  to 35°C on 2 M $\Omega$  and 20 M $\Omega$  ranges;  $\leq 70\%$  to 50°C

**Protection Class 2:** Relates solely to insulation and grounding properties defined in IEC 348

**Power:** Single 9V battery, NEDA 1604

**Battery Life:** 200 hours typical with alkaline battery; 100 hours typical with zinc-carbon battery

**Battery Indicator:** "BT" appears on LCD display when approximately 20% of battery life remains

**Size:** 180 mm L x 86 mm W x 45 mm H (7.1 in L x 3.4 in W x 1.8 in H)

**Weight:** 0.37 kg (0.82 lb)

**Included:** Manual, test leads (Y8132), 9V battery, spare 2A fuse, operator's card, Statement of Calibration Practice

## Models

January 1985 prices

8026B DMM w/2-year warranty	\$199
8020B DMM w/2-year warranty	194

## Accessories (Also see page 55)

Y8132 Replacement Test Leads	10
Y8134 Deluxe Test Lead Set	20
Y8140 Slim Test Leads, w/needle points	18
80K-6 High Voltage Probe	45
80K-40 High Voltage Probe	80
83RF 100 MHz RF Probe	49
85RF 500 MHz RF Probe	85
80T-150C Temperature Probe, °C	120
80T-150F Temperature Probe, °F	120
80i-400 AC Current Probe	69
80i-600 AC Current Probe	99
Y8100 DC/AC Current Probe	199
Y8101 AC Current Probe	59
Y8105 Ruggedized Carrying Case	20
A81 Battery Eliminator	20
C90 Carrying Case	10

## After-Warranty Service (See page 227)

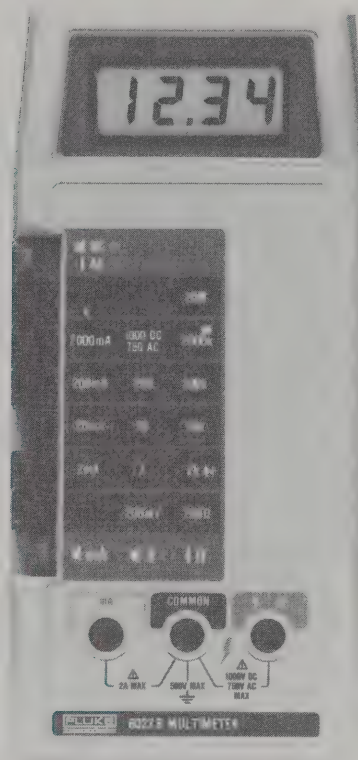
SC1-8026B, per 90-day interval	17
SC1-8020B, per 90-day interval	16

# HANDHELD MULTIMETERS

Available through Distributors (See page 248) . . . 8021B/8022B



8021B



8022B

## 8021B & 8022B, Rugged & Economical

- 3½ digits (2000 counts)
- Six functions including diode test
- Plus high-speed audible continuity (8021B)
- 0.25% basic dc accuracy
- 2-year warranty, 2-year calibration cycle
- Bail with detent position
- Extensive overload protection
- UL 1244 listed
- Shock and vibration per MIL-T-28800, Class 5
- Optional accessories for measuring rf, high voltage, high current
- Battery eliminator (A-81) is also available

These rugged 3½-digit handheld DMMs were designed for the person who needs the following six basic measurement functions: dc and ac volts, dc and ac amps, ohms, and diode test.

Both electrical and mechanical features make these DMMs the world's best in their class. For instance, they meet the vibration and shock test requirements for Class 5 instruments outlined in U.S. Military Specification MIL-T-28800. Overload protection circuits prevent damage to the instrument caused by accidental operator errors, including voltage input transients up to 6 kV. The current input has two in-series fuses, one for normal overload situations — a common 2A, 250V variety — and a second for high-energy fault conditions, like accidentally connecting the DMM to a 480V ac power line. A crystal-controlled oscillator gives Fluke handheld DMMs the best 60 Hz or 50 Hz line noise rejection available in any handheld DMM.

The simple front panel layout makes the DMMs easy to use. A comprehensive owner's manual clearly explains the unit's operation, and typical measurement techniques are covered so you can get the most out of your DMM.

## Specifications

All accuracy specifications apply for two years after purchase or recalibration when operated in a temperature of 18°C to 28°C and a relative humidity of up to 90%, unless otherwise noted.

### DC Voltage

Ranges:  $\pm 200$  mV,  $\pm 2$  V,  $\pm 20$  V,  $\pm 200$  V,  $\pm 1000$  V

Resolution: 100  $\mu$ V on 200 mV range

Accuracy:  $\pm(0.25\%$  of reading + 1 digit), all ranges

### Input Impedance: 10 M $\Omega$ , all ranges

Normal Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz

Common Mode Noise Rejection:  $\geq 100$  dB at dc, 50 Hz, and 60 Hz, with  $\leq 1$  k $\Omega$  unbalance

Overload Protection: 1000V dc or peak ac on all ranges

Response Time:  $< 1$  second

### AC Voltage (Average-Sensing, RMS-Indicating)

Range	Resolution	Accuracy 45 Hz to 450 Hz
200 mV	100 $\mu$ V	$\pm(1\%$ of reading + 3 digits)
2V	1 mV	
20V	10 mV	
200V	0.1V	
750V	1V	

Conversion: Calibrated for rms value of sinewaves

Input Impedance: 10 M $\Omega$ ,  $\leq 100$  pF, all ranges

Common Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz, with  $\leq 1$  k $\Omega$  unbalance

Overload Protection: 1000V dc or 750V rms ac, continuous, except 15 seconds maximum above 300V rms on 200 mV range

Response Time:  $< 2$  seconds



# HANDHELD MULTIMETERS

**8021B/8022B . . . Available through Distributors (See page 248)**

## Resistance

Range	Resolution	Accuracy ±[% of Rdg + Digits]	Full Scale Voltage	Max Test Current
200 Ω	0.1Ω	0.3% + 3	<0.25V	0.35 mA
2 kΩ*	1Ω	0.2% + 1	>1.0V	1.1 mA
20 kΩ	10Ω		<0.25V	13 μA
200 kΩ*	100Ω		>0.7V	13 μA
2000 kΩ	1 kΩ	2% + 1	<0.25V	0.13 μA
20 MΩ*	10 kΩ		>0.7V	0.13 μA

\*Diode test ranges

**Diode Test:** The three diode test ranges have enough open circuit voltage to turn on silicon junctions allowing a diode test. The 2 kΩ range is preferred and is marked with a diode symbol. The three other ranges will not turn on silicon junctions when making in-circuit resistance measurements

**Open Circuit Voltage:** Less than 1.5V on all ranges except 2 kΩ range is 3.5V or less

**Input Protection:** 500V dc or rms ac on all ranges, 15 seconds maximum above 300V

## Continuity (8021B only)

**Resistance Ranges:** All. The 2 kΩ range is recommended for lowest resistance threshold

**Indication:** Audible tone for continuity; no tone for open circuit

**Response Time:** (2 kΩ range) 50 μs minimum duration of continuity or open to toggle tone on or off. A pulse-stretcher circuit produces or interrupts the tone for about 200 ms when a short duration continuity or open occurs

**Input Protection:** Same as for resistance measurements

## DC Current

Range	Resolution	Accuracy	Burden Voltage
2 mA	1 μA	±(0.75% of reading + 1 digit)	0.3V max
20 mA	10 μA		
200 mA	100 μA		
2000 mA	1 mA		0.9V max

**Overload Protection:** 2A/250V and 3A/600V fuse in series

## AC Current

Range	Resolution	Accuracy ±[% of Rdg + Digits]		Burden Voltage (RMS)
		45 Hz to 450 Hz	450 Hz to 1 kHz	
2 mA	1 μA	2% + 2	Not Spec'd	0.3V max
20 mA	10 μA	1.5% + 2		
200 mA	100 μA			
2000 mA	1 mA			0.9V max

**Conversion:** Calibrated for rms value of sinewaves

**Overload Protection:** 2A/250V and 3A/600V fuse in series

## General Specifications

**Display:** 3½ digits (2000 counts), LCD, autozero, autopolarity

**Common Mode Voltage:** 500V dc or rms ac, max

**Shock and Vibration:** Per MIL-T-28800, Class 5

**Temperature:** 0°C to 50°C, operating; -35°C to +60°C, non-operating

**Temperature Coefficient:** <0.1 x the applicable accuracy specification per °C from 18°C to 0°C or 28°C to 50°C

**Relative Humidity:** ≤90% to 35°C except ≤80% to 35°C on 2 MΩ and 20 MΩ ranges; ≤70% to 50°C

**Protection Class 2:** Relates solely to insulation or grounding properties defined in IEC 348

**Power:** Single 9V battery, NEDA 1604

**Battery Life:** 200 hours typical with alkaline battery; 100 hours typical with zinc-carbon battery

**Battery Indicator:** "BT" appears on LCD display when approximately 20% of battery life remains

**Size:** 180 mm L x 86 mm W x 45 mm H (7.1 in L x 3.4 in W x 1.8 in H)

**Weight:** 0.37 kg (0.82 lb)

**Included:** Manual, operator's card, test leads (Y8132), 9V battery, spare fuse, Statement of Calibration Practice

## Models

January 1985 prices

8021B DMM w/audible continuity	\$159
8022B DMM	154

## Accessories (Also see page 55)

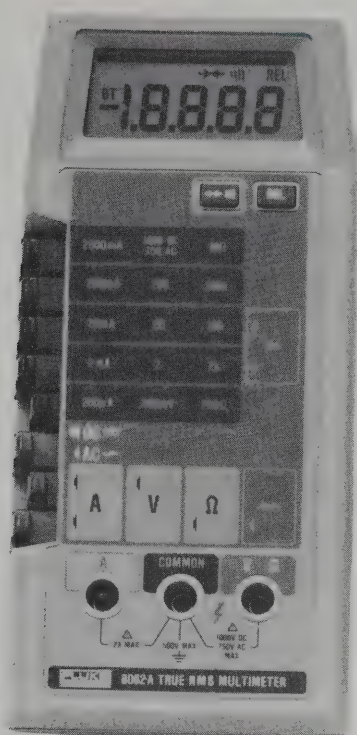
Y8132 Replacement Test Leads	10
Y8134 Deluxe Test Lead Set	20
Y8140 Slim Test Leads, w/needle points	18
80K-6 High Voltage Probe	45
80K-40 High Voltage Probe	80
83RF 100 MHz RF Probe	49
85RF 500 MHz RF Probe	85
80T-150C Temperature Probe, °C	120
80T-150F Temperature Probe, °F	120
80i-400 AC Current Probe	69
80i-600 AC Current Probe	99
Y8100 DC/AC Current Probe	199
Y8101 AC Current Probe	59
Y8105 Ruggedized Carrying Case	20
A81 Battery Eliminator	20
C90 Carrying Case	10

## After-Warranty Service (See page 227)

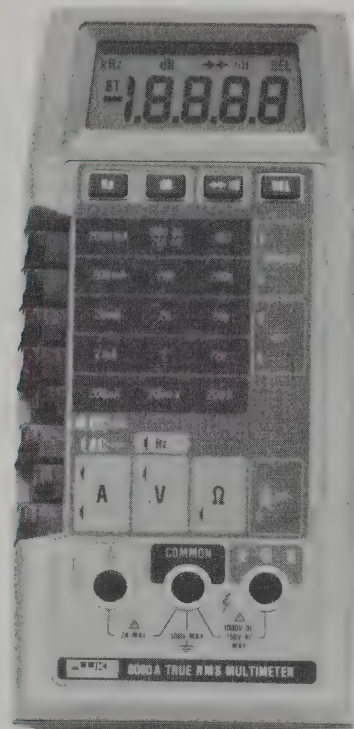
SC1-8021B, per 90-day interval	15
SC1-8022B, per 90-day interval	15

# HANDHELD MULTIMETERS

Available through Distributors (See page 248) . . . 8060A/8062A



8062A



8060A

## 8062A, Precision 4½-Digit DMM

- 4½-digit (20,000 count) resolution
- True-rms ac measurements
- Fast audible/visual continuity tests
- Relative reference (offset)
- Low-power ohms on all resistance ranges
- Constant-current diode test mode
- Measure resistances to 300 M $\Omega$
- True-rms ac voltages to 30 kHz
- 0.05% basic dc accuracy
- Self diagnostics
- UL 1244 listed

The 8060A and 8062A 4½-digit handheld DMMs offer more measurement capabilities than found in most bench/portable models. They are Fluke's finest microcomputer-based handheld DMMs offering unique features never before found in a small low-cost DMM. The 8060A even measures *frequency* — from 12 Hz to more than 200 kHz — autoranging over four ranges from 200 Hz to 200 kHz.

At the touch of a single button you can select V, Hz, and dB.

### Relative Reference

The microcomputer lets you automatically subtract lead resistance when measuring ohms and display only the difference between a stored reference value and a measured value. The relative mode is great for measuring changes, especially in dB and frequency measurements.

### Overload Protected & Rugged

The 8060A and 8062A are well-suited to the needs of engineers and technicians skilled in audio, video, telecommunication, or computer

## 8060A, World Standard 4½-Digit DMM With Frequency

- 4½-digit (20,000 count) resolution
- True-rms ac measurements
- Fast audible/visual continuity tests
- Relative reference (offset)
- Low-power ohms on all resistance ranges
- Constant-current diode test mode
- Measure resistances to 300 M $\Omega$
- True-rms ac voltages to 30 kHz
- 0.04% basic dc accuracy
- Self diagnostics
- UL 1244 listed

### Plus

- *Frequency.* . . 12 Hz to 200 kHz functional to 700 kHz
- True-rms ac voltages to 100 kHz
- dBm or relative dB measurements
- Conductance measurements

technology. They are designed using the same rugged case and safety engineered jacks, test leads, and double-fused current inputs found on other Fluke handheld DMMs. And the same extensive overload protection is built in for the other functions and ranges.

### Automatic M $\Omega$ Range Selection

To keep the front panel simple, there is only one manually-selectable position above 200 k $\Omega$ . When that position is used, the appropriate 2 M $\Omega$ , 20 M $\Omega$ , or 300 M $\Omega$  range is automatically selected.



# HANDHELD MULTIMETERS

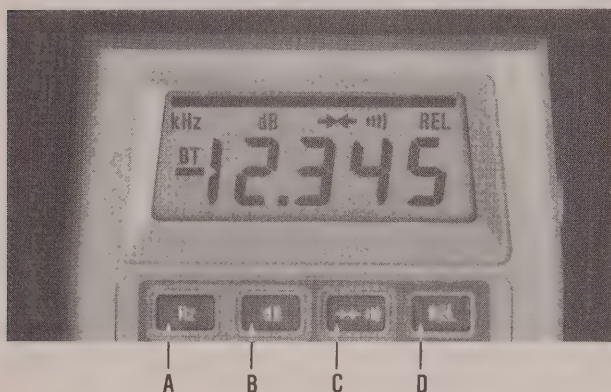
8060A/8062A . . . Available through Distributors (See page 248)

## Frequency

It is easy to accurately measure the dB gain or loss of amplifiers, filters, attenuators, etc. with a DMM that has dB readout. To combine that feature in a handheld DMM that also measures *frequency* provides a nearly ideal test instrument for many applications. When you need the best in a handheld DMM, you should buy the 8060A. It has features you won't find even in most bench/portable DMMs.

## True-rms ac

Because true-rms measurements of ac yield accurate results on non-sinusoidal waveforms as well as sinewaves, the 4½-digit resolution, wide bandwidth, and exceptional accuracy of the 8060A and 8062A make them a superior tool for exacting technical people.



## Special Functions

Several special annunciator symbols appear in the display as a reminder of what mode or modes have been selected when pushbuttons **A**, **B**, **C**, and **D** are used. Only pushbuttons **C** and **D** and corresponding functions appear on the 8062A.

(A) Pushing the Hz button when in the ac voltage mode selects the frequency function. The best of four ranges (200 Hz, 2 kHz, 20 kHz, and 200 kHz) is then automatically selected for frequencies between 12 Hz and 200 kHz. Readings are updated every 1.3 seconds or less even for low-frequency ranges.

(B) Pushing the dB button converts voltage readings to the equivalent in decibels. The reading may be relative to 1 milliwatt (dBm) across a 600 ohm load, or they may be relative to any level previously stored as a "relative reference."

(C) This pushbutton converts resistance measurements to fast indications of continuity, either audibly with a beep tone or quietly by the appearance of the solid black bar across the top of the display. Continuity as brief as 50 microseconds is enough to be recognized, stored, and indicated.

(D) When you first push the REL button it stores the displayed reading and subsequently subtracts that value from all subsequent readings for that measurement function. REL appears in the display as a reminder until the 8060A or 8062A is turned off or the pushbutton is pressed a second time.

## Specifications

All accuracy specifications apply for one year after purchase or recalibration when operated in a temperature of 18°C to 28°C and a relative humidity of up to 80%, unless otherwise noted.

### DC Voltage

Ranges:  $\pm 200$  mV,  $\pm 2$  V,  $\pm 20$  V,  $\pm 200$  V,  $\pm 1000$  V

Resolution: 10  $\mu$ V on the 200 mV range

Input Impedance: 10 M $\Omega$  on all ranges, >1000 M $\Omega$  selectable for 200 mV and 2V ranges

Accuracy:  $\pm$ (% of Rdg + Digits)

Range	8060A	8062A
200 mV, 2V	0.04% + 2*	0.05% + 2
20V, 200V, 1000V	0.05% + 2	0.07% + 2

\*Accuracy  $\pm$ (0.05% of reading + 2 digits) for >1000 M $\Omega$  input impedance

Normal Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz

Common Mode Noise Rejection:  $\geq 120$  dB at dc,  $\geq 90$  dB at 50 Hz and 60 Hz, with 1 k $\Omega$  unbalance

Overload Protection: 1000V dc, 750V rms ac (not to exceed a volt-hertz product of  $10^7$ ) on all ranges, continuous except limited to 20 seconds on 200 mV and 2V ranges

Response Time:  $\leq 1$  second to rated accuracy

### AC Voltage (True-RMS, AC Coupled)

Ranges: 200 mV, 2V, 20V, 200V, 750V

Resolution: 10  $\mu$ V on the 200 mV range

Input Impedance: 10 M $\Omega$ ,  $\leq 100$  pF (dBm mode also)

Crest Factor: Waveforms with peak/rms ratio of 1:1 to 3:1

Voltage Readout, 8060A: From 5% to 100% of Range

Range	Accuracy: $\pm$ (% of Rdg + Digits)						
	20 Hz	45 Hz	1 kHz	10 kHz	30 kHz	50 kHz	100 kHz
200 mV	1%+10	0.2%+10	0.2%+20	0.5%+40	1%+100	3%+200	
2V		0.5%+10	0.5%+20	1%+40	2%+100		
20V							
200V							
750V	Not Spec'd	1%+10	Not Specified				

Voltage Readout, 8062A: From 5% to 100% of Range

Range	Accuracy: $\pm$ (% of Rdg + Digits)				
	20 Hz	45 Hz	500 Hz	1 kHz	10 kHz
200 mV				0.5% + 20	1% + 40
2V	1% + 10		0.5% + 10		
20V				5% + 20	5% + 40
200V					
750V	Not Spec'd		2% + 10	Not Specified	

dBm, 600 $\Omega$  Reference, 8060A: From 5% to 100% of Range (-50 to +60 dBm)

Range	Accuracy: $\pm$ dB					
	20 Hz	45 Hz	1 kHz	10 kHz	30 kHz	50 kHz
2.45 mV-10.23 mV	$\pm 0.5$		$\pm 1.0$	$\pm 3.0$	Not Specified	
10.24 mV-19.99 mV		$\pm 0.2$		$\pm 0.5$	$\pm 1.0$	$\pm 2.2$
20 mV-199.99V		$\pm 0.15$		$\pm 0.3$	$\pm 0.65$	$\pm 1.2$
200V-750V		$\pm 0.5$	Not Specified			

Useful Frequency Range: -3 dB at 420 kHz at 100% of range, 220 kHz at 5% of range, typical

Common Mode Noise Rejection:  $\geq 60$  dB at 50 Hz and 60 Hz, 1 k $\Omega$  unbalance

Overload Protection: 1000V dc or peak ac, 750V rms ac (not to exceed a volt-hertz product of  $10^7$ ) on all ranges, continuous, except 300V dc or rms ac on the 200 mV and 2V ranges for 20 seconds maximum

Response Time:  $\leq 5$  seconds to rated accuracy, any range

# HANDHELD MULTIMETERS

Available through Distributors (See page 248) . . . 8060A/8062A

## DC Current

Range	Resolution	Accuracy: $\pm$ (% Rdg + Digits)		Burden Voltage
		8060A	8062A	
200 $\mu$ A 2 mA	0.01 $\mu$ A 0.1 $\mu$ A	0.2% + 2	0.3% + 2	$\leq$ 0.3V
20 mA	1 $\mu$ A	0.3% + 2	0.7% + 2	$\leq$ 0.9V
200 mA	10 $\mu$ A			
2000 mA	100 $\mu$ A			

**Input Protection:** 2A/250V fuse in series with 3A/600V fuse  
**Response Time:**  $\leq$ 5 seconds to rated accuracy

## AC Current (True-RMS)

Has dc-coupled current path, ac-coupled voltage-sensing circuits.  
**Ranges, Resolution, Burden Voltage:** Same as for dc current

**Accuracy, 8060A:**  $\pm$ (% of Rdg + Digits)

Range	20 Hz to 45 Hz	45 Hz to 3 kHz	3 kHz to 10 kHz	10 kHz to 30 kHz
200 $\mu$ A 2 mA 20 mA	1% + 10	0.75% + 10	2% + 20	2% + 40
200 mA				
2000 mA			Not Specified	

**Accuracy, 8062A:**  $\pm$ (% of Rdg + Digits)

Range	20 Hz to 45 Hz	45 Hz to 3 kHz	3 kHz to 10 kHz	10 kHz to 30 kHz
200 $\mu$ A 2 mA 20 mA	1% + 10	0.75% + 10	2% + 20	2% + 40
200 mA				
2000 mA				Not Specified

**Crest Factor:** 1:1 to 3:1

**Response Time:**  $\leq$ 3 seconds to rated accuracy

## Resistance

**Ranges:** 200 $\Omega$ , 2 k $\Omega$ , 20 k $\Omega$ , and 200 k $\Omega$  manually selected plus 2 M $\Omega$ , 20 M $\Omega$ , 100 M $\Omega$ , and 300 M $\Omega$  automatically selected in the M $\Omega$  range

## Resolution and Accuracy

Range	Resolution	Accuracy: $\pm$ (% of Rdg + Digits)	
		8060A	8062A
200 $\Omega$	0.01 $\Omega$	0.07% + 2 + 0.02 $\Omega$	0.1% + 2 + 0.02 $\Omega$
2 k $\Omega$ 20 k $\Omega$ 200 k $\Omega$	0.1 $\Omega$ 1 $\Omega$ 10 $\Omega$	0.07% + 2	0.1% + 2
2 M $\Omega$ *	100 $\Omega$		
20 M $\Omega$ *	10 k $\Omega$		
100 M $\Omega$ *	100 k $\Omega$	1% + 3	1% + 3
300 M $\Omega$ *	1 M $\Omega$	2% + 3	2% + 3

\* These four autoranging M $\Omega$  ranges have a high enough source voltage to turn on a silicon junction

**Open Circuit Voltage:**  $\leq$ 2.5V all ranges, except  $\leq$ 4.8V on 200 $\Omega$  range

**Overload Protection:** 500V dc or rms ac on all ranges

**Response Time:**  $\leq$ 2 seconds to rated accuracy except  $\leq$ 8 seconds on M $\Omega$  ranges

## Continuity

**Ranges:** All resistance ranges

**Threshold:** For 8060A,  $\leq$ 10% of any range used through 200 k $\Omega$  range and  $\leq$ 20 k $\Omega$  above 200 k $\Omega$  range. For 8062A,  $\leq$ 50% of range and nominally  $<$ 100 k $\Omega$  above 200 k $\Omega$  range.

**Indication:** Horizontal bar in display, plus audible tone when desired  
**Response Time:**  $\leq$ 50  $\mu$ s continuity,  $\geq$ 200 ms indication

## Diode Test

The diode test function displays the voltage-drop across a semiconductor junction using a 1 mA ( $\pm$ 10%) constant current supply and a 2V range. All resistance ranges up to and including the 200 k $\Omega$  range have less than enough source voltage to forward-bias a semiconductor junction, so that they can be used for in-circuit measurements.

**Reading Accuracy:**  $\pm$ (0.05% + 2 digits) for 8060A,  $\pm$ (0.06% + 2 digits) for 8062A

**Overload Protection:** 500V dc or rms ac

**Response Time:**  $\leq$ 2 seconds to rated accuracy

## Conductance (8060A only)

**Range:** 2000 nS (equivalent to 500 k $\Omega$ )

**Resolution:** 0.1 nS

**Accuracy:** (0.5% of reading + 20 digits)

**Overload Protection:** 500V dc or rms ac

## Relative Reference

When the REL button is pushed the displayed reading is stored as a reference and subtracted from subsequent readings to indicate the amount of deviation.

**Accuracy:** Error will not exceed the sum of the errors of the reference reading and subsequent readings

## Frequency (8060A only)

**Ranges:** 200 Hz, 2000 Hz, 20 kHz, and 200 kHz, automatically selected in the Hz mode, ac voltage function. Measures down to 12 Hz. Will measure to 700 kHz in Extended Frequency Mode.

**Resolution:** 0.005% of range, e.g. 0.01 Hz in 200 Hz range

**Accuracy:**  $\pm$ (0.05% of reading + 1 digit)

**Input Impedance:** Ac coupled into 10 M $\Omega$ ;  $<$ 100 pF

**Sensitivity:** For sinewaves,  $\geq$ 10% of voltage range to 20 kHz,  $\geq$ 25% of voltage range to 100 kHz,  $\geq$ 75% of voltage range to 200 kHz

**Response Time:**  $\leq$ 1 second above 16 Hz,  $\leq$ 1.3 seconds from 12.2 Hz to 16 Hz, to rated accuracy

## General Specifications

**Calibration Cycle:** One-year for specified accuracy

**Display:** 4½ digits (20,000 counts), LCD, autozero, autopolarity, low battery (BT) indicator

**Max. Common Mode Voltage:** 500V dc or rms ac

**Temperature:** 0°C to 50°C operating; -35°C to 60°C non-operating

**Temperature Coefficient:**  $\leq$ 0.1 times the applicable accuracy specification per °C from 18°C to 0°C or 28°C to 50°C

**Relative Humidity:**  $\leq$ 70% to 50°C or  $\leq$ 80% to 35°C but  $\leq$ 70% when measuring resistance above 20 M $\Omega$

**Shock and Vibration:** Per MIL-T-28800, Class 5

**Safety:** UL 1244 listed

**Power:** Single 9V battery, NEDA 1604, typically 170 hours of operation with alkaline type

**Size:** 180 mm L x 86 mm W x 45 mm H (7.1 in x 3.4 in x 1.8 in)

**Weight:** 0.41 kg (0.90 lb)

**Included:** Manual, Y8132 test leads, 9V battery, operator's card, spare fuse, Statement of Calibration Practice

## Models

January 1985 prices

8060A DMM, measures frequency ..... \$349  
8062A DMM ..... 295

## Accessories (Also see page 55)

83RF RF Probe ..... 49  
80K-6 High Voltage Probe ..... 45  
Y8101 Clamp-on AC Current Probe ..... 59

Also see page 230 for more accessory information.

## After-Warranty Service (See page 227)

SC1-8060A, per 90-day interval ..... 24  
SC1-8062A, per 90-day interval ..... 23





# MULTIMETER ACCESSORIES

## Introduction

Today's multimeters become even more powerful tools through the use of accessories. High voltage or high current probes can scale hazardous voltages and currents to levels safe to measure with a low cost multimeter. High frequency ac rf probes allow the accurate measurement of signals which might otherwise require the use of an expensive oscilloscope. Temperature probes convert temperature readings to millivolts, allowing multimeters to be substituted for dedicated temperature instruments.

Fluke presently offers the broadest range of DMM accessories available from any manufacturer. Although similar accessories are offered by other manufacturers, Fluke accessories are unsurpassed in quality of design and workmanship. Nothing less would be acceptable from the

world leader in Digital Multimeters. And our accessories are compatible with other manufacturers' DMMs.

Accessories are an integral part of the Fluke strategy to provide customers with cost effective solutions to a wide range of measurement problems.

Emphasizing this commitment, our newest accessory, the 80i-400 ac current clamp offers exceptional performance at an attractive price. One of four current clamps from Fluke, the 80i-400 incorporates a jaw shape particularly well suited for probing among the congested wires of a typical electrical power panel.

See the selection guide below and the following pages for further information on how accessories can enhance your DMM.

## Selection Guide

ACCESSORIES	DIGITAL VOLTMETERS and MULTIMETERS																														
	8025A	25	27	73	75	77	8010A	8012A	8020B	8021B	8022B	8024B	8026B	8050A	8060A	8062A	8500A	8502A	8505A	8506A	8520A	8522A	8600A	8810A	8840A	8860A	8920A	8921A	8922A		
TL70 Test Lead Set	(4)	(4)	(4)	(4)	(4)	(4)	—	—	•	•	•	•	•	•	•	•	—	—	—	—	—	—	—	—	(4)	—	—	—	—		
Y8131 Test Lead Set	—	—	—	—	—	—	(4)	(4)	—	—	—	—	—	—	—	—	•	•	•	•	•	•	•	•	—	(1)	•	(1)	—		
Y8132 Test Lead Set	•	•	•	•	•	•	—	—	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	—	—	—	—	—	—	—	—	•	—	•	(1)	—		
Y8133 Test Lead Kit	—	—	—	—	—	—	•	•	—	—	—	—	—	—	—	—	•	•	•	•	•	•	•	•	—	•	(1)	•	(1)		
Y8134 Test Lead Kit	•	•	•	•	•	•	—	—	•	•	•	•	•	•	•	•	—	—	—	—	—	—	—	—	•	•	(1)	•	(1)		
Y8140 Test Lead Set	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	(1)	•	(1)	
C20 Hardcase	(4)	•	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
C25 Softcase	•	•	•	(6)	(6)	(6)	—	—	•	•	•	•	•	—	•	•	—	—	—	—	—	—	—	—	—	—	—	—	—		
C70 Holster	—	—	—	•	•	(4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
C71 Softcase	—	—	—	•	•	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
C86 Hardcase	—	—	—	—	—	—	•	•	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—		
C90 Softcase	—	—	—	(6)	(6)	(6)	—	—	•	•	•	•	•	—	•	•	—	—	—	—	—	—	—	—	—	—	—	—	—		
Y8105 Hardcase	—	—	—	—	—	—	—	—	•	•	•	•	•	—	•	•	—	—	—	—	—	—	—	—	—	—	—	—	—		
Y8205 Softcase	—	—	—	—	—	—	•	•	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—		
A81 Battery Eliminator	—	—	—	—	—	—	—	—	•	•	•	•	•	—	•	•	—	—	—	—	—	—	—	—	—	—	—	—	—		
80T-H Touch-Hold Probe	(5)	(5)	(5)	—	—	(5)	•	•	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
83RF R.F. Probe	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(1)	•	(1)	
85RF R.F. Probe	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(1)	•	(1)	
80T-150 Temp. Probe	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	(1)	•	(1)	
80T-SP Temp. Probe	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Y8102 Temp. Probe	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Y8103 Temp. Probe	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Y8104 Temp. Termination	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
80K-6 H.V. Probe	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(1)	•	(1)	
80K-40 H.V. Probe	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(1)	•	(1)	
80J-10 Current Shunt	—	—	—	—	—	—	—	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	(1)	•	(1)
Y8100 Current Probe	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	(1)	•	(1)
Y8101 Current Probe	•	•	•	—	•	•	•	•	•	•	•	•	•	•	•	•	(3)	(3)	(3)	(3)	(3)	(3)	(3)	•	(3)	•	(3)	(3)	(3)	(3)	(3)
80i-400 Current Probe	•	•	•	—	•	•	—	—	•	•	•	•	•	•	•	•	(3)	(3)	(3)	(3)	(3)	(3)	(3)	•	(3)	•	(3)	(3)	(3)	(3)	(3)
80i-600 Current Probe	•	•	•	—	•	•	•	•	•	•	•	•	•	•	•	•	(3)	(3)	(3)	(3)	(3)	(3)	(3)	•	(3)	•	(3)	(3)	(3)	(3)	(3)
Y9108 BNC Adapter	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	—	•	—	
Y9109 BNC Adapter	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	

• Means compatible and recommended

— Not compatible, not recommended, or not applicable

(1) Y9109 Adapter required

(2) On some ranges inputs must be shunted to equal 10 MΩ

(3) Current-measuring option required or A90

(4) Included with DMM

(5) Feature of DMM w/o probe

(6) Accommodates DMM with C70 Holster



# MULTIMETER ACCESSORIES

Available through Distributors (See page 248)

Convenience accessories simplify circuit connections, probe hard-to-reach places, and protect instruments.



## Y8131 Test Lead Set

Four-foot test leads feature banana plugs on one end and detachable probes with solid pin tips and finger guards on other end. See Selection Guide for compatible DMMs.

## Y8132 Test Lead Set

Same as Y8131 except safety designed banana plugs are shrouded by an insulating shield. See Selection Guide for compatible DMMs.

## Y8140 Test Lead Set

Slim four-foot test leads that have retractable, insulated needle point tips for adjustable lengths. Tough, thin insulation extends all the way to the points to prevent shorting adjacent components or conductors. Needle points easily pierce varnish and thin insulation to give good electrical contact. See Selection Guide for compatible DMMs.

## TL70 Test Lead Set

Safety-designed right angle plugs shrouded by insulating shield. Strain relief where wire joins probes. See Selection Guide for compatible DMMs.

## Y8133 Test Lead Kit

Y8133 includes a black and a red insulated wire lead each having an exposed banana plug on one end and a safety-designed, shrouded banana plug on the other. Leads have strain relief for long life. Also included are two insulated alligator clips, two spade lug tips, a spring-loaded hook tip, and two probes with solid metal pin tips and finger guards. Any of the clips, tips, and probes may be plugged onto the shrouded banana plug on either wire lead. See Selection Guide for compatible DMMs.

## Y8134 Test Lead Kit

Same as Y8133 Test Lead Kit except banana plugs are shrouded by an insulating shield on both ends of each lead. See Selection Guide for compatible DMMs.

## Y9134 Alligator Clips

Package of ten insulated alligator clips with banana jack. Five red and five black. For Y8131 through Y8134.

## Y9104 Alligator Clips

Package of six black slip-on insulated alligator clips for ground connections. Compatible with pin-tip size probes except TL70.

## AC70 Alligator Clips

Package of four slip-on, insulated alligator clips. Two red and two black. Compatible with TL70 or other pin-tip size probes.

## Y8205 Soft Carrying Case

A soft vinyl plastic container designed for the storage and transport of either an 8000A, 8010A, 8012A, 8050A, or 8600A DMM. A separate storage compartment is provided for test leads and other compact accessories.

## C25 Soft Carrying Case

Thickly padded vinyl with tough exterior and interior and heavy-duty water resistant zipper. Holds DMM and test leads. Includes combination belt loop/carrying strap and two storage pockets. For Fluke 25/27 and 8025A. Also accommodates small accessories and Fluke 70 Series Meters in C70 holster.

# MULTIMETER ACCESSORIES

Available through Distributors (See page 248)

## C71 Soft Carrying Case

A soft, zippered vinyl case for Fluke 70 Series Multimeters. Includes pocket for test leads.

## C90 Soft Carrying Case

Constructed of double-wall, fabric-backed vinyl with padded interior and zippered closure for complete protection. Inside pocket holds test leads and operator's instruction card. Carrying strap doubles as belt loop holder. Accommodates 70 Series DMMs in C70 Holster. See Selection Guide for compatible DMMs.

## C20 Hard Carrying Case

The C20 is a heavy duty hard case made of shock resistant hard plastic. A carrying handle, operator's guide decal, and storage compartment for test leads and other small items is included. The cover is secured by two latches that also latch the case top to the back of the case for convenient storage and to form a tilt-up stand. For Fluke 25/27 and included with Fluke 8025A.

## C86 Hard Carrying Case

The Model C86 Carrying Case is a molded polyethylene container designed for either an 8010A, 8012A, 8000A, 8050A, or 8600A DMM. This rugged case provides the DMM with maximum protection against rough handling and adverse weather conditions. A separate storage compartment is provided for test leads and other compact accessories.

## Y8105 Hard Carrying Case

A tough, hard plastic case that provides protection against rough handling and bad weather. Will also hold 80i-600, 80i-400 or Y8101 Current Probes and smaller accessories. Resembles C86. See Selection Guide for compatible Handheld Multimeters.

## C70 Multipurpose Holster

The C70 is for Fluke 70 Series Multimeters and is included with the Fluke 77 model. It is made of a tough semiflexible plastic that snaps over the instrument to absorb shocks and protect the meter from rough handling. The holster also doubles as a tilt stand. Includes a neck strap and belt clip for easy hands-free viewing while standing. Holster stores test leads and probes. Probes may be snapped into holster so only one hand is needed to hold both the meter and probe tip in contact with test point.

## A81 Battery Eliminator

The A81 provides line operation for DMMs without discharging their disposable batteries. Available in three line voltage versions. Specify version desired. See Selection Guide for compatible DMMs.

**A81-115** 115V input (U.S. plug)

**A81-230** 230V input (European plug)

**A81-100** 100V input (U.S. plug)

## 80T-H Touch-Hold Probe

The 80T-H is a direct signal-through test probe with a touch and hold feature. Touch-and-hold allows voltage or resistance readings to be held on a digital multimeter display following contact of the probe tip with the test point. Operator can devote full attention to manipulating the probe until the measurement is complete, then remove the probe and observe the reading on the DMM. Activation of a pushbutton on the probe causes the DMM to hold the last number displayed until the pushbutton is released. Works with 8010A, 8012A, 8050A only.

### Voltage Rating

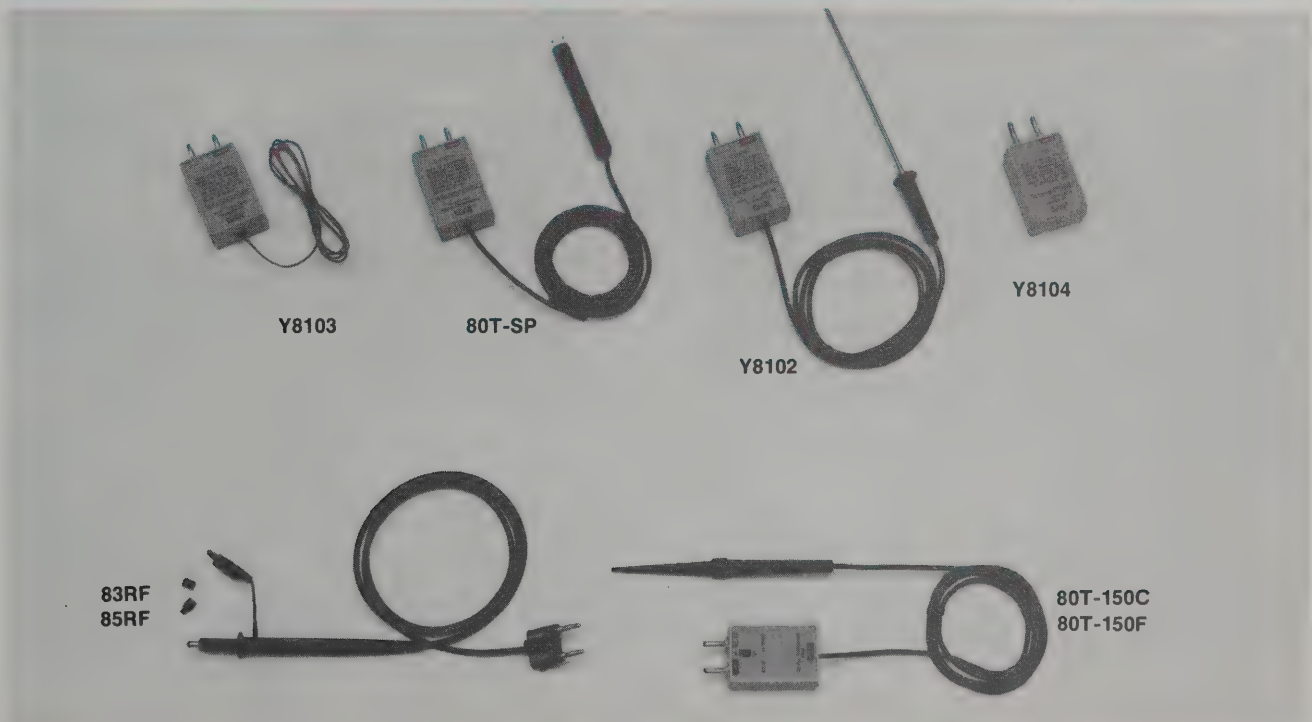
Tip to Common: 1000V dc or peak ac maximum

Common to Ground: 60V dc or 42V peak ac maximum

**Input Capacitance:** 150 pF maximum

**Lead Resistance:** 0.5Ω maximum

Extend the measurement capabilities of your DMM to include temperature and high-frequency measurements.





# MULTIMETER ACCESSORIES

Available through Distributors (See page 248)

## 83RF High Frequency Probe

The 83RF converts a dc voltmeter into a high frequency, 100 kHz to 100 MHz, ac voltmeter. Conversion from ac to dc is on a one-to-one basis over a range of 0.25 to 30V rms. The probe's dc output is calibrated to be equivalent to the rms value of a sinewave input.

**AC-to-DC Ratio:** 1:1

**Ratio Accuracy:**  $\pm 1$  dB above 1V;  $\pm 1.5$  dB below 1V (at 1 MHz with 10 M $\Omega$  load)

**Frequency Response:**  $\pm 1$  dB 100 kHz to 100 MHz (relative to 1 MHz)

**Extended Frequency Response:** Relative readings from 20 kHz to 250 MHz

**Response:** Responds to peak value of input; calibrated to read rms value of a sinewave

**Voltage Range:** 0.25 to 30V rms

**Maximum Input Voltage:** 30V rms, 200V dc

**Input Capacitance:** Approximately 3 pF

## 85RF High Frequency Probe

The 85RF is designed to convert a dc voltmeter into a high frequency, 100 kHz to 500 MHz, ac voltmeter. Ac to dc conversion ratio is one-to-one over a range of 0.25 to 30V rms. The probe's dc output is calibrated to the rms value of a sinewave input.

**AC-to-DC Ratio:** 1:1

**Ratio Accuracy:**  $\pm 0.5$  dB above 0.5V (at 1 MHz with 10 M $\Omega$  load)  $\pm 1$  dB below 0.5V

**Frequency Response:**  $\pm 0.5$  dB 100 kHz to 100 MHz;  $\pm 1.0$  dB 100 MHz to 200 MHz;  $\pm 3.0$  dB 200 MHz to 500 MHz\* (relative to 1 MHz)

**Extended Frequency Response:** Relative readings from 20 kHz to 700 MHz

**Response:** Responds to peak value of input; calibrated to read rms value of a sinewave

**Voltage Range:** 0.25 to 30V rms

**Maximum Input Voltage:** 30V rms, 200V dc

**Input Capacitance:** Approximately 3 pF

\*Referred to high and low inputs at probe tip

## 80T-150 Temperature Probe

The 80T-150 is a universal temperature probe designed to provide virtually all DMMs with temperature measuring capability. Primarily intended for ambient and surface measurements, the probe provides a direct temperature conversion of 1 mV per degree. In use, the temperature-to-voltage converter box is plugged into the dc input of the DMM and the probe tip exposed to the material to be measured. An outstanding feature of particular importance to electronically-oriented users is the probe's ability to stand off voltages to 350V dc that may be present on devices whose temperature is being measured. Resolution is 0.1° on the 200 mV range of a 3½-digit DMM. Order 80T-150C to read degrees Celsius or 80T-150F to read degrees Fahrenheit. A probe may be made to indicate either °C or °F but must be calibrated when you make a change.

**Temperature Range:** -50°C to +150°C (80T-150C); -58°F to +302°F (80T-150F), cable 70°C maximum

**Celsius-Fahrenheit Selection:** Internal solder jumpers

**Sensitivity:** 1 mV per °C or °F

**Resolution:** 0.1°C or 0.1°F recommended maximum

**Ambient Temperature Range:** 0°C to +50°C

**Relative Humidity:**  $\leq 80\%$ , non-condensing

**Accuracy:** (Including nominal 0.25% voltmeter error, in +15°C to +35°C ambient)

+15°C to 35°C ambient:  $\pm 1^\circ\text{C}$  (1.8°F) 0°C to 100°C, decreasing linearly to  $\pm 3^\circ\text{C}$  (5.4°F) at -50°C and +150°C

0°C to +15°C and +35°C to 50°C ambient: Add 1°C (1.8°F) to above

## 80T-SP Type K Surface Thermocouple

For use with 8024A and 8024B for measuring the temperature of flat or slightly convex surfaces.

**Response Time:** 3 seconds

**Range:** -20°C to 260°C, handle and cable 105°C maximum

**Accuracy:**  $\pm 2.2^\circ\text{C}$  from -20°C to 260°C (with respect to NBS thermocouple tables). Also depends on good contact between the tip and the surface to be measured.

**Probe Diameter:** 12.5 mm (.5 in)

**Probe Length:** 9.4 cm (3.75 in)

**Conductor Length:** 1.12m (48 in)

## Y8102 Type K Thermocouple Probe

Designed for use with Fluke 8024A and 8024B Digital Voltmeter. Sheath material is Inconel, especially good for liquid immersion measurements.

**Time Constant:** 10 seconds, for air at room temperature and one atmosphere of pressure moving 65 feet per second

**Temperature Range:** 0°C to 926°C (32°F to 1700°F)

**Accuracy:**  $\pm 2.2^\circ\text{C}$  from 0°C to 276.7°C and  $\pm 0.75\%$  of reading from 276.7°C to 926°C

**Probe Diameter:** 3.18 mm (0.125 inch)

**Probe Length:** 15.2 cm (6 inches)

**Conductor Length:** 1.12 meters (48 inches)

## Y8103 Type K Bead Thermocouple

For use with 8024A and 8024B in any application except liquid immersion or penetration. Exposed tip provides fast response. Teflon insulation. Four feet.

**Time Constant:** 2 seconds, for air at room temperature and one atmosphere of pressure moving 65 feet per second

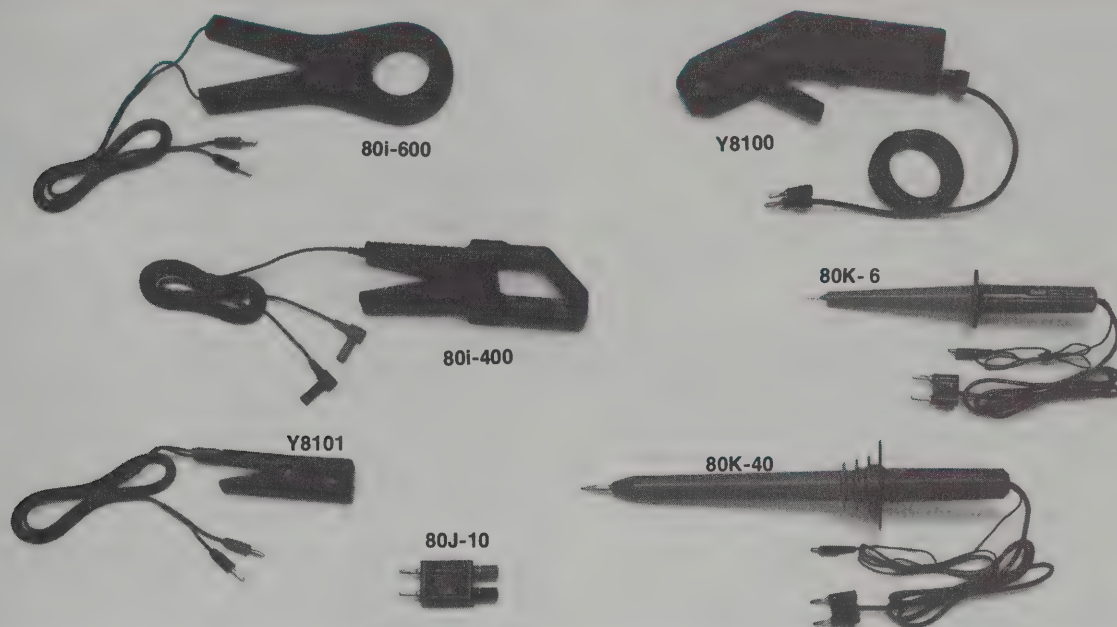
**Temperature Range:** -150°C to +260°C (-238°F to +500°F)

**Accuracy:**  $\pm 2.2^\circ\text{C}$  from -17.8°C to +260°C

## Y8104 Thermocouple Termination

Provides isothermal termination for any Type K thermocouple wire connected to 8024A and 8024B. Maximum wire size is #14 AWG. Ensures no temperature difference between the junctions created by the instrument terminals in contact with the thermocouple terminals.

These probes protect you and your DMM from high voltage and high current without interrupting the circuit under test.



## 80K-6 High Voltage Probe

The 80K-6 extends the voltage measuring capability of an ac/dc voltmeter up to 6000 volts. A 1000:1 voltage divider provides a high input impedance. High accuracy is provided when the divider is used with a voltmeter having a 10 M $\Omega$  input impedance. A molded plastic body houses the divider and protects user from voltage being measured.

**Voltage Range:** 0 to 6 kV, dc or peak ac

**Input Impedance:** 75 M $\Omega$ , nominal

**Division Ratio:** 1000:1

### Accuracy

DC to 500 Hz:  $\pm 1\%$

500 Hz to 1 kHz:  $\pm 2\%$

Above 1 kHz: Output reading falls; typically, -30% at 10 kHz

**DVM Compatibility:** The 80K-6 achieves rated accuracy when used with an ac/dc voltmeter having 0.25% accuracy, or better, and an input impedance of 10 M $\Omega \pm 10\%$ .

**Caution:** These probes are not intended for electric utility applications in which high voltage is also accompanied by high energy. Rather, they are intended for use in lower energy applications such as television and CRT troubleshooting.

## 80K-40 High Voltage Probe

The Model 80K-40 is a high voltage accessory probe designed to extend the voltage measuring capability of an ac/dc voltmeter up to 40,000 volts. In essence the probe is a precision 1000:1 voltage divider formed by two matched metal-film resistors. The unusually high input impedance offered by these resistors minimizes circuit loading and optimizes measurement accuracy. A special plastic body houses the divider and provides the user with isolation and protection from the voltage being measured.

**Voltage Range:** 1 kV to 40 kV dc or peak ac, 28 kV rms ac

**Input Resistance:** 1000 M $\Omega$

**Division Ratio:** 1000:1

**DC Accuracy:**  $\pm 2\%$  from 20 kV to 30 kV (calibrated 1% at 25 kV); changes linearly from 2% at 30 kV to 4% at 40 kV and from 2% at 20 kV to 4% at 1 kV

**AC Accuracy:**  $\pm 5\%$  at 60 Hz

**DVM Compatibility:** The 80K-40 provides rated accuracy when used with any voltmeter having a 10 M $\Omega$  input impedance. When used with voltmeters with other input impedances, a correction factor and/or shunt resistor is used to obtain the correct value.

**Caution:** These probes are not intended for electrical utility applications in which high voltage is also accompanied by high energy. Rather, they are intended for use in lower energy applications such as television and CRT troubleshooting.

## Y8100 Clamp-on DC or AC Current Probe

The Model Y8100 is a clamp-on, Hall-effect probe that can be used with a voltmeter, multimeter, or oscilloscope to read dc, ac, or composite (ac/dc) current measurements. The pistol shape allows safe, easy, one-hand operation when making current measurements. Two ranges, 20A and 200A, produce a 2V output at full range current. The probe battery-low indicator light lets the operator know when the battery voltage is too low for proper operation.

**Ranges:** 20A ac or dc and 200A ac or dc

### Accuracy:

DC to 200 Hz:  $\pm 2\%$  of range

200 Hz to 1 KHz:  $\leq 100A$  add  $\pm 3\%$  of reading;

$\geq 100A$  add  $\pm 6\%$  of reading

**Working Voltage:** Core to output; 600V dc or 480V ac maximum. Output to ground; 42V dc or 30V ac maximum

**Maximum Conductor Size:** 1.9 cm (.75 in)



# MULTIMETER ACCESSORIES

Available through Distributors (See page 248)

## Y8101 Clamp-on AC Current Probe

The Y8101 is a small clamp-on current transformer designed to extend the current measuring capability of a DMM or ac current meter up to 150 amperes. The coil on the clamp-on core serves as the secondary of a 1000:1 ratio transformer. The current-carrying conductor being measured serves as the primary.

**Current Range:** 1A to 150A

**Accuracy:** 48 Hz to 62 Hz  $\pm(2\%$  of reading  $+0.15A$ );  
62 Hz to 1000 Hz  $\pm(3\%$  of reading  $+0.15A$ )

**Division Ratio:** 1000:1

**Working Voltage:** 300V ac rms maximum

**Maximum Conductor Size:** 1.11 cm (0.43 in)

**Usable Current Range:** 0.1A to 200A, 5 seconds maximum above 150A

## 80i-400 Clamp-on AC Current Probe

The Model 80i-400 is a clamp-on current probe designed to extend the current capability of an ac current meter to 400 amperes. A clamp-on, 1000-turn coil designed into the probe allows measurements to be made without breaking the circuit under test. The current carrying conductor being measured serves as the primary. The unique shape of the 80i-400 jaw will accommodate a single 750 MCM THHN (30mm diameter) conductor or two 500 MCM THHN (25mm diameter each) conductors run in parallel.

**Current Range:** 1A to 400A

**Accuracy:**  $\pm(3\%$  of reading  $+0.4A$ ) 48 Hz to 440 Hz  
 $\pm(4\%$  of reading  $+0.4A$ ) 440 Hz to 1000 Hz

**Division Ratio:** 1000:1

**Working Voltage:** 660V ac rms maximum

**Maximum Conductor Size:** 1 each 30mm (1.18 in) or 2 each 25mm (0.98 in)

**Usable Current Range:** 0.1A to 600A, 5 seconds maximum above 400A

## 80i-600 Clamp-on AC Current Probe

The Model 80i-600 is a clamp-on current transformer designed to extend the current measuring capability of a DMM or current meter to 600 amperes. A coil on the clamp-on transformer core allows measurements to be made without breaking the circuit under test. This coil serves as the secondary of a 1000:1 transformer. The current-carrying conductor being measured serves as the primary. Because of a high efficiency, evenly distributed winding, wire size and location of the wire within the transformer jaws will not affect the accuracy of current measurements.

**Current Range:** 1A to 600A

**Accuracy:**  $\pm(2\%$  of reading) 48 Hz to 1000 Hz

**Division Ratio:** 1000:1

**Working Voltage:** 750V ac rms maximum

**Maximum Conductor Size:** 5 cm (2 in)

**Usable Current Range:** 0.04A to 2000A, 5 seconds maximum above 600A

## 80J-10 Current Shunt

An inexpensive, simple-to-use accessory that lets you measure ac or dc current using any sensitive voltmeter having banana jack inputs with a standard  $\frac{1}{4}$ " spacing. Two 5-way binding posts become the current input terminals. The precision, 0.01 $\Omega$  shunt resistor will pass 10 amperes continuously without overheating, or up to 20 amperes for one minute. Not compatible with Y8132, Y8134 or TL70 test lead sets.

**Sensitivity:** 10 mV per ampere

**Shunt Resistance:** 0.01 $\Omega$

**Accuracy:**  $\pm 0.25\%$ , from dc to 10 kHz, typically rising to 1 dB at 100 kHz

**Series Inductance:** 8.3 nH

**Overload:**  $>20A$ , not fused

## Specifications

### Rack-Width Rack Adapters

Fluke bench/systems instruments are designed to be easily mounted in a standard 19-inch rack cabinet. Some have rack-mount panels and some need rack adapters. When adapters are required they are listed with the instrument — among its recommended accessories.

### Portable Instrument Rack Adapters

#### Multimeter Rack Adapters, $3\frac{1}{2}$ " High

8010A M00-200-611, M00-200-612, and M00-200-613

8012A, 8050A, 8600A Same as for 8010A

### BNC-Banana Adapter

BNC-to-banana adapters permit interconnection between equipment having BNC plugs and equipment with double banana jacks. Caution: Do not use BNC Connectors for floating measurements.

Y9108 BNC Jack to Double Banana Plugs

### M00-100-714 Panel Protectors

A front panel protector is a molded plastic, snap-on accessory which fits over the front panel of a DMM, counter, etc. The cover provides protection for the front panel controls, and is useful for storing or transporting the instrument.

## Accessories

January 1985 prices

A81 Battery Eliminator .....	\$ 20
AC70 Alligator Clips .....	5
C20 Hard Carrying Case .....	20
C25 Soft Carrying Case .....	15
C70 Multi-purpose Holster .....	9
C71 Soft Carrying Case .....	9
C86 Hard Carrying Case .....	20
C90 Soft Carrying Case .....	10
M00-100-714 Panel Protectors .....	10
TL-70 Test Lead Set .....	5
Y8100 DC/AC Current Probe .....	199
Y8101 AC Current Probe .....	59
Y8102 Type K Thermocouple Probe (for 8024B only) .....	60
Y8103 Type K Bead Thermocouple (for 8024B only) .....	25
Y8104 Thermocouple Termination (for 8024B only) .....	10
Y8105 Hard Carrying Case .....	20
Y8131 Test Lead Set .....	10
Y8132 Test Lead Set .....	10
Y8133 Test Lead Set .....	20
Y8134 Test Lead Set .....	20
Y8140 Test Lead Set .....	18
Y8205 Soft Carrying Case .....	35
Y9104 Alligator Clips .....	12
Y9108 BNC-Banana Adapter .....	10
Y9134 Alligator Clips .....	17
80i-400 AC Current Probe .....	69
80i-600 AC Current Probe .....	99
80K-6 High Voltage Probe .....	45
80J-10 Current Shunt .....	30
80K-40 High Voltage Probe .....	80
80T-150C Temperature Probe .....	120
80T-H Touch-Hold Probe .....	45
80T-SP Type K Surface Thermocouple (for 8024B only) .....	95
83RF High Frequency Probe .....	49
85RF High Frequency Probe .....	85

## Introduction

The Fluke line of electronic counters provides frequency, period, time interval, events totalizing and frequency ratio measurements in the range of dc to 1.3 GHz. Fluke counters are accurate, reliable, transportable and cost competitive, designed to meet the stringent accuracy and stability demands placed on today's digital measurement equipment. Low power battery operated ovenized units can be aligned in the calibration lab and remain stable while transported to the measurement location. Some models offer IEEE-488 bus operation.

## Selection Guide

Characteristics	7250A	7260A	7261A	7220A	1900A	1910A	1911A	1912A	1953A
Measurement									
Basic Frequency (MHz)	80	125	125	1300	80	125	250	520	125
Optional Channel (C)	—	1300*	1300*	—	—	—	—	—	1250*†
Frequency Ratio A/B	●	●	●	—	—	**	**	**	●
Period and Time Resolution	100 ns	100 ns	10 ns	—	100 ns	100 ns	100 ns	100 ns	100 ns
Period Average Resolution	1 ps	1 ps	0.1 ps	—	100 ps	100 ps	100 ps	100 ps	1 ps
Time-Interval-Average Res.	—	31.6 ps	31.6 ps	—	—	—	—	—	—
Modulated Timebase Option	—	—	●	—	—	—	—	—	—
Counts Per Minute (x100)	●	●	●	—	—	—	—	—	—
Totalize A	●	(4)	(4)	—	●	●	●	●	(4)
Triggering									
AC or DC Coupling	AC	Both	Both	AC	AC	AC	AC	AC	Both
+ or - Slope	●	●	●	—	—	—	—	—	●
50 MHz Sensitivity (rms)	10 mV	10 mV	10 mV	10 mV	25 mV	15 mV	15 mV	15 mV	30 mV
Noise Filter	●	●	●	●	●	—	—	—	—
10x, 100x Attenuation	(1)	Both	Both	(1)	10x	10x	10x	10x	10x
Trigger Level Control	(2)	●	●	—	—	●	●	●	●
Trigger Level Lights	—	●	●	—	—	—	—	—	●
Trigger Level Output	—	●	●	—	—	—	—	—	●
Marker Output	—	●	●	—	—	—	—	—	●
Time Interval Holdoff	—	●	●	—	—	—	—	—	—
Timebase									
TCXO Option	●	●	●	●	—	●	●	●	Std.
Oven Options	Two	Two	Two	Two	—	—	—	—	Two
External Input	●	●	●	●	—	●	●	●	●
Internal Output	—	●	●	●	—	—	—	—	●
Miscellaneous									
Number of Digits	7	8	8	9	6	7	7	7	9
Autoranging	●	●	●	●	●	●	●	●	—
Battery Option	●	●	●	●	●	●	●	●	—
Data Output Option	●	●	●	●	●	●	●	●	●
IEEE-488 Option	(3)	(3)	(3)	(3)	—	—	—	—	●
RFI Shielding (MIL-STD-461)	●	●	●	●	—	—	—	—	—
USA Basic Price	\$990	\$1245	\$1405	\$1300	\$410	\$570	\$675	\$825	\$1660

\*Also 520 MHz option available

\*\*Using external timebase input

† Also 1000 MHz option

(1) 1x to 10x variable plus 10x switch

(2) Three switch-selectable levels

(3) Via Fluke 1120A IEEE-488 Translator

(4) Gated totalize



# THEORY, FEATURES & TERMS

## Frequency Measurements

Frequency counters totalize the number of events or cycles that occur during a precisely known time interval. The counter's highly accurate and stable timebase, often referred to as the clock, provides the time reference needed to set the precise measurement interval or gate time.

## Period Measurements

Fluke multifunction and universal counter/timers determine the period by totalizing the number of cycles of a known clock (timebase) that occur during the single-cycle period of the input signal. Period *averaging* occurs by totalizing the number of clock cycles that occur during a specific number (N) of signal cycles (e.g., 10, 100, etc.) then dividing the total by N.

Period measurements may be used to determine low frequencies more quickly and accurately than frequency measurements because the long period of a low frequency wave allows a large number of counts to accumulate.

## Time Interval Measurements

Sometimes referred to as the start-stop mode, this function provides a time interval measurement between two events on separate signals or between two separate points on one waveform.

In time interval measurements, the main gate is controlled by two independent inputs: the start input (A) and the stop input (B). When one external signal is applied to input A, the main gate is opened and clock pulses from the timebase are accumulated. When the stop signal is applied, the main gate closes and the accumulated count shows the time between the start and stop signals. The resolution of the measurement depends on the timebase frequency. A 10 MHz clock provides 100 ns resolution. This function is only available in the Universal/Counter Timer type counters.

## Ratio Measurements

When ratio measurements are made, two input signals are connected to a universal counter/timer. One signal is fed into the A input. The other signal is fed into the B input and controls the main gate. Normally, the higher of the two frequencies to be ratioed is fed into the A input. To achieve high resolution, averaging techniques similar to period averaging are employed.

The ratio measurement is useful in production testing to compare two frequencies such as measuring gear ratios and testing frequency dividers or multipliers. This function is only available in the Universal/Counter Timer type counters.

## Totalizing Measurements

In totalize mode, the timebase is not used. The main gate is left in the open position and the input signal is simply fed into the counter for a period determined by the user. In universal counter/timers the gate can be controlled remotely for semi-automated totalizing measurements. The counter will display the number of pulses received during the interval between opening and closing the gate.

## Trigger Level Output

To specify and duplicate critical timing tests such as rise time and fall time measurements, the start and stop trigger levels must be measured and specified. The counter that has a trigger level output makes it easy for you to measure the levels and duplicate the test set-up and results.

## Marker Output

For time measurements on complex waveforms, it may be advisable to use an oscilloscope to identify the time interval measured. If your counter has a marker output, that pulse can be applied to the second channel of a dual-trace oscilloscope or the Z-axis input to bracket and identify the measured interval.

## Time Interval Holdoff

When measuring time intervals or counting events that recur periodically, as pulse trains or signal bursts, it is important to be able to confine the measurement to one set of events per measurement. If your counter has a time interval holdoff control, it makes the job simple.

## Phase-Modulated Timebase

For the most precise measurement of time intervals, numerous intervals should be measured using the Time-Interval-Average mode. However, often when such measurements need to be made the signal to be measured is under control of a clock nearly as accurate as the counter timebase. Then repeated measurements of successive intervals may contain a consistent error that will not disappear when averaged. A randomly phase-modulated timebase solves the problem.

## AC or DC Coupling

Pulses that vary in duration or repetition rate have an average level that increases and decreases even if the peak levels do not change. When ac coupled, the average level always corresponds to zero volts, and, as the duration or rep rate changes, the + and — peak levels move up or down together on opposite sides of the zero-volt level. The net effect is unstable triggering. DC coupling solves this problem if you don't have to use ac coupling to block a high level dc component.

## Timebase Options

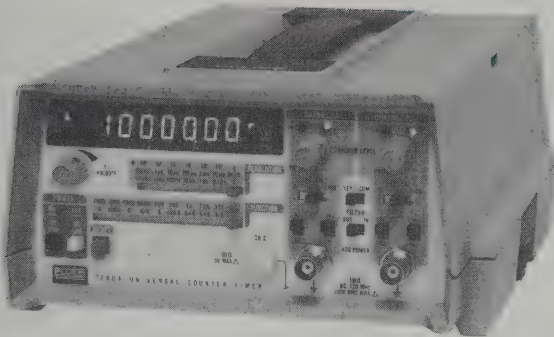
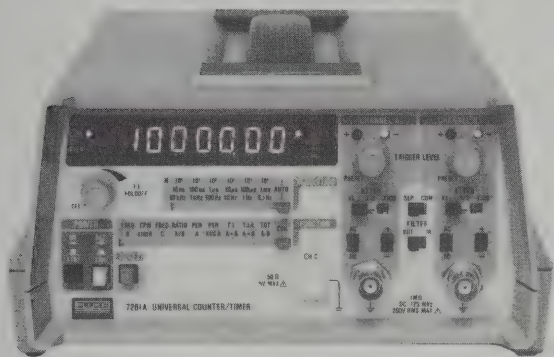
Fluke produces three types of timebases offering three general levels of price and performance.

Free-air timebases are uncompensated crystal oscillators; therefore, they are most affected by temperature variation.

Temperature-compensated crystal oscillators (TCXOs) offer significantly improved performance over free-air timebases with respect to temperature variations.

Ovenized timebases offer the best attainable stability for a proportionately higher price. Typical aging rate is  $\pm 1 \times 10^{-9}$ /day with the best ovens offering  $\pm 5 \times 10^{-10}$ /day, providing a longer calibration cycle.

# UNIVERSAL COUNTER/TIMERS

**7260A/7261A**

**7260A**

**7261A**

## 7260A & 7261A Universal Counter/Timers

- 8-digit display
- 100 MHz clock/10 nS resolution (Model 7261A)
- Phase modulation timebase option available on Model 7261A
- X1, X10, X100 attenuation
- 100 kHz low-pass filter
- Selectable + or — slope triggering and ac or dc coupling

The 7260A and 7261A are Fluke Counter/Timers packaged in the versatile Portable Test Instrument (PTI) case. Both counters will measure frequencies to 125 MHz, or (optionally) to 520 MHz or 1300 MHz, with a 50Ω channel (Channel C).

The instruments are essentially alike except the 7261A has a 100 MHz clock, with a corresponding basic resolution of 10 ns, and the 7260A has a 10 MHz clock, with 100 ns resolution. Both counters will make time-interval or signal-period measurement and will average from  $10^0$  to  $10^5$  such measurements per reading when greater resolution or accuracy is desired. That extends the resolution of the 7261A to 31.6 ps for time-interval measurements or to 0.1 ps for period measurements. In addition, the 7261A is available with a unique phase-modulated timebase option to assure averaging out small consistent errors.

A broadband attenuator lets you select 1X, 10X or 100X attenuation to minimize interference from signal noise and to trigger near the peak of high amplitude signals. And a switchable 100 kHz low-pass filter solves the problem of high frequency contamination of audio frequency signals. The signal may be dc coupled or ac coupled and

either + or — slope of the sign may be selected for triggering. The Channel A and Channel B trigger level controls have a zero-volt preset position for easy triggering on sinewaves and other signals that cross the zero-volt level.

Trigger status lights tell when triggering is unstable, and the precise trigger level setting of both channels may be monitored at a rear panel connector. Also at the rear panel is a marker output — a gate signal that brackets each period or time-interval measurement. The marker is for use with an oscilloscope. The trigger level and marker outputs are for making accurate timing measurements such as the rise time and fall time of complex signals. A time interval holdoff control with a 1000:1 ratio (20  $\mu$ s to 20 ms) delays the end of the marker gate to measure the precise portion of a signal that you want to.

## Simple, Hands-Off Operation

But you don't have to use all the controls and features. These counters are designed to let you keep your hands and mind on the job instead of on the counter controls. Select the measurement function you want, set the resolution switch to AUTO range and they will automatically choose the correct range for best resolution, position the decimal point properly, and light an annunciator LED to inform you of the unit of measurement.

## Portable Counter, Ovenized Accuracy

For applications demanding the best possible accuracy, ovenized timebase oscillators are available. These oscillators consume such low power they can be used when the counters are operating from batteries. When you go out on a field assignment you can switch to battery power and keep the oscillator warm and standing by for instantaneous use with maximum stability and accuracy. There are two oven options to choose from, one with an accuracy of  $\pm 1 \times 10^{-7}$ , and one with an accuracy of  $\pm 3 \times 10^{-8}$ , over the 0°C to 40°C temperature range.

## IEEE-488 and PTI

The Fluke-developed portable test instrument (PTI) packaging concept allows you to easily configure low-cost, convenient mini-test systems using the Fluke 1120A IEEE-488 Translator. A number of compatible Fluke instruments can be interfaced via the 1120A, including counters and digital voltmeters. The unique stack-and-latch design makes them easy to carry about. Means less bench space, too.

## Low Susceptibility, Minimal RF Radiation

A lightweight, internal, stainless steel shield completely surrounds the instruments and mates with the metal front and rear panels to provide an rf enclosure meeting most requirements of MIL-STD-461. This means low susceptibility in high rf environments as well as minimal radiated energy to interfere with nearby rf-sensitive equipment.

## Specifications

### Frequency Measurements (Channel A)

Range: 0 Hz to 125 MHz

Resolution: 0.1 Hz to 10 kHz, in decade steps

Accuracy:  $\pm 1$  count  $\pm$  timebase error\*

Display: kHz or MHz with decimal

\*See Timebase Characteristics chart

### Frequency Measurements, Channel C (Option -310 or -331)

Range: 50 MHz to 520 MHz (Option -310); 100 MHz to 1300 MHz (Option -331)

Resolution: 0.1 Hz to 10 kHz, in decade steps

Accuracy:  $\pm 1$  count  $\pm$  timebase error\*

Display: kHz or MHz with decimal

\*See Timebase Characteristics chart



# UNIVERSAL COUNTER/TIMERS

## 7260A/7261A

### Ratio Measurements (A/B)

**Range:** 0 Hz to 125 MHz for channel A, 0 Hz to 2 MHz for Channel B  
**Resolution:**  $\pm$  frequency of B  $\div$  N\* x frequency of A  
**Accuracy:** Resolution  $\pm$  frequency of B x trigger error of B  $\div$  N\*  
**Display:** Decimal, no annunciator

### Period Measurements (Channel A)

**Range:** 100 ns to 999,999.99 seconds for 7260A, or 10 ns to 99,999.999 seconds for 7261A  
**Frequency Range:** 0 Hz to 2 MHz, sinewave  
**Pulse Width:**  $\geq$ 500 ns from 0 Hz to 100 kHz,  $\geq$ 250 ns from 100 kHz to 2 MHz  
**Resolution:** 10 ms to 100 ns in decade steps for 7260A, or 1 ms to 10 ns in decade steps for 7261A  
**Accuracy:**  $\pm$ 1 count  $\pm$  timebase error  $\pm$  trigger error  
**Display:** ms, or sec with decimal for 7260A,  $\mu$ s, ms, or sec with decimal for 7261A

### Period-Averaged Measurements (CH A)

**Range:** 1 ps to 9,999,999.9  $\mu$ s for 7260A; 0.1 ps to 999,999.99  $\mu$ s for 7261A  
**Frequency Range:** 0 Hz to 2 MHz, sinewave  
**Pulse Width:**  $\geq$ 500 ns from 0 Hz to 100 kHz,  $\geq$ 250 ns from 100 kHz to 2 MHz  
**Resolution:** 100 ns to 1 ps in decade steps for 7260A; 10 ns to 0.1 ps in decade steps for 7261A  
**Accuracy:** 100 ns  $\div$  N\*  $\pm$  timebase error  $\pm$  trigger error  $\div$  N\* for 7260A, or 10 ns  $\div$  N\*  $\pm$  timebase error  $\pm$  trigger error  $\div$  N\* for 7261A  
**Display:**  $\mu$ s or ms with decimal

\*N =  $10^0$  to  $10^5$  in decade steps set by resolution switch. Indicates the number of periods averaged in period average mode, the number of intervals averaged in time interval average mode, or the number of cycles averaged in ratio mode.

### Time-Interval Measurements (CH A/CH B)

**Range:** 100 ns to 999,999.99 sec, for 7260A, or 10 ns to 99,999.999 sec. 7261A  
**Frequency Range:** 0 Hz to 5 MHz, sinewave  
**Pulse Width:**  $\geq$ 50 ns, for 7260A,  $\geq$ 10 ns for 7261A  
**Resolution:** 100 ns to 10 ms in decade steps for 7260A, 10 ns to 1 ms in decade steps for 7261A  
**Accuracy:**  $\pm$ 1 count  $\pm$  timebase error  $\pm$  trigger error  
**Display:** ms or sec 7260A;  $\mu$ s, ms, sec 7261A  
**Time Interval Holdoff:** 20  $\mu$ s to 20 ms, continuously variable

### Time-Interval-Averaged Measurements (CH A/CH B)

**Range:** 1 ns to 9,999,999.9  $\mu$ s for 7260A, or 0.1 ns to 999,999.99  $\mu$ s for 7261A  
**Frequency Range:** 0 Hz to 5 MHz, sinewave  
**Pulse Width:**  $\geq$ 50 ns for 7260A,  $\geq$ 10 ns for 7261A  
**Resolution:** 100 ns  $\div$   $\sqrt{N}$ \* for 7260A, 10 ns  $\div$   $\sqrt{N}$ \* for 7261A  
**Accuracy:** 100 ns  $\div$   $\sqrt{N}$ \*  $\pm$  10 ns  $\pm$  timebase error  $\pm$  trigger error  $\div$   $\sqrt{N}$ \* for 7260A; 10 ns  $\div$   $\sqrt{N}$ \*  $\pm$  timebase error  $\pm$  trigger error  $\div$   $\sqrt{N}$ \* for 7261A  
**Dead Time:** 4  $\mu$ s  
**Display:**  $\mu$ s ms, with decimal

\*N =  $10^0$  to  $10^5$  in decade steps set by resolution switch. Indicates the number of periods averaged in period average mode, the number of intervals averaged in time interval average mode, or the number of cycles of B averaged in ratio mode.

### Totalize (CH A Gated by CH B)

**Range:** 0 Hz to 125 MHz for channel A, 0 Hz to 2 MHz for channel B  
**Count Capacity:** 99,999,999  
**Display:** Total count, no decimal or annunciator  
**Time Interval Holdoff:** Range, 20  $\mu$ s-20-ms, cont variable

### Counts Per Minute (cpm x100, CH A)

**Range:** 0 Hz to 125 MHz  
**Count Time:** 600 ms (1/100 minute)  
**Resolution:** 100 cpm, fixed  
**Accuracy:**  $\pm$ 1 count  $\pm$  timebase error  
**Display:** No decimal or annunciator

### Channel A & B Input Characteristics

**Bandwidth:** 0-125 MHz, dc coupled; 5 Hz-125 MHz, ac coupled  
**Selection:** Separate or A connected to B (Sep/Com)  
**Sensitivity:** 10 mV rms, 0 to 50 MHz; 15 mV rms, 50 to 100 MHz; 35 mV rms, 100-125 MHz  
**Minimum Pulse:** 50 ns at 50 mV pk (7260A); 10 ns at 50 mV pk (7261A)  
**Impedance:** 1 M $\Omega$ , 50 pF, nominal  
**Coupling:** ac or dc  
**Attenuator:** X1, X10, X100, switchable  
**Slope:** + or -, switchable  
**Filter:** Low pass, 100 kHz 3 dB point, nominal  
**Trigger Level Range:** +1.5V to -1.5V  
**Linear Operating Range:** +2.5V to -2.5V  
**Maximum Input:** 100V rms 0 Hz to 45 Hz, 250V rms 45 Hz to 50 kHz decreasing to 5V rms at 1 MHz, 5V rms 1 MHz to 125 MHz

### Channel C Input Characteristics (Option -310 or -331)

**Bandwidth:** 50 MHz to 520 MHz (Option -310); 100 MHz to 1300 MHz (Option -331)  
**Sensitivity:** 10 mV rms (Option -310); 5 mV rms to 600 MHz, 10 mV rms from 600 MHz to 1000 MHz, 40 mV rms from 1000 MHz to 1300 MHz (Option -331)  
**Impedance:** 50 $\Omega$ , 2.5: 1 VSWR, maximum  
**Maximum Input:** 5V rms, fused

### External Timebase Input

**Frequency:** 10 MHz, ac coupled  
**Sensitivity:** 300 mV rms  
**Impedance:** 1 k $\Omega$ , 30 pF, nominal  
**Maximum Input:** 3V rms

### Triggering

**Trigger Level Output:**  $\pm$ 1.5V level indicates dc trigger level set on either Channel A or B, switch-selectable  
**Trigger Status Indicators:** Two per channel provide positive indication that the input signal is triggering the input amplifier and relative indication as to where on the signal the input amplifier is being triggered  
**Cont/Trig Mode:** Rear panel switch activates external trigger mode for initiating a measurement

### Timebase Characteristics

Characteristics	Option			
	Standard	-112 TCXO	-131 Oven	-132 Oven
Frequency	10 MHz	10 MHz	10 MHz	10 MHz
Aging Rate (Const. Temp)	$\pm 5 \times 10^{-7}$ /mo	$\pm 3 \times 10^{-7}$ /mo $\pm 1 \times 10^{-6}$ /yr	$\pm 1 \times 10^{-7}$ /mo*	$\pm 5 \times 10^{-8}$ /mo* $\pm 3 \times 10^{-9}$ /day*
Temperature Accuracy (0°C to 40°C)	$< 5 \times 10^{-6}$ **	$\pm 2 \times 10^{-6}$	$\pm 1 \times 10^{-7}$	$\pm 3 \times 10^{-8}$
Line Variation ( $\pm 10\%$ change)	$\pm 1 \times 10^{-7}$	$\pm 2 \times 10^{-8}$	$\pm 2 \times 10^{-8}$	$\pm 4 \times 10^{-9}$
Battery Operation	$\pm 1 \times 10^{-7}$	$\pm 2 \times 10^{-8}$	$\pm 5 \times 10^{-8}$	$\pm 1 \times 10^{-8}$
Warm-up 10 Minutes	—	—	$\pm 5 \times 10^{-7}$	$\pm 5 \times 10^{-7}$
20 Minutes	—	—	$\pm 3 \times 10^{-8}$	$\pm 3 \times 10^{-8}$

\* After 5 days of continuous operation

\*\* Peak-to-peak variation over temperature range

- (1) Timebase error is the sum of all errors specified for the particular timebase (see timebase specifications)
- (2) Trigger error is the measurement error caused by noise on the input signal triggering the input amplifier too early or too late, calculated as follows:

$$\text{Microseconds of trigger error} = \frac{2 \times \text{pk noise voltage (V)}}{\text{signal slope at trigger point (V/\mu s)}}$$

or Trigger error =  $\pm 0.3\%$  of one period divided by periods averaged for signals with better than 40 dB signal to noise ratio and 100 mV rms amplitude, whichever is greater.

# UNIVERSAL COUNTER/TIMERS

**7260A/7261A**

## Option Specifications

### Battery Pack Option (-010)

Type: Nickel-Cadmium, size F

Operating Time: 2.8 hours (2 hours, 7261A) typical continuous, decreasing to 2 hours (1.5 hours, 7261A) worst case

Charge Time: 16 hours at room temperature

Charge Protection: Thermistor-actuated shutdown of charging circuit if battery temperature exceeds 65°C

Discharge Protection: Automatic low-voltage shutdown to prevent over discharge

Note: Not compatible with Option -331

### PTI Interface (-521)

Type: Serial BCD output of all digits and measurement units

Levels: TTL, "1" state low

### Personality Card Option (-522K)

For 1120A IEEE-488 Translator. Part of Option -529

### IEEE-488 Interface Option (-529)

Description: Interfaces the 7260A or 7261A to IEEE-488 via the Fluke 1120A IEEE-488 Translator. (Note: 1120A must be purchased separately.) Provides full measurement output capability as well as remote selection of all functions and ranges.

Repertoire: SH1, AH1, T5, L4, SR1, RL2, DC1, DT1

Timebase Phase Modulation Option (-190) 7261A only

Description: Option insures valid time interval averaging of clock-synchronous signals by phase modulating internal timebase

### 520 MHz Channel C Option (-310)

Description: Provides third channel input to measure frequencies from 50 MHz to 520 MHz

Sensitivity: 10 mV rms

Input Impedance: 50Ω

VSWR: 2.5:1, maximum

Maximum Input: 5V rms, fuse-protected

### 1300 MHz Channel C Option (-331)

Description: Provides third channel input to measure frequencies from 100 MHz to 1300 MHz and has a triggered mode to capture and display bursts as short as 3.6 ns

Sensitivity: 5 mV rms to 600 MHz, 10 mV rms from 600 MHz to 1000 MHz, 40 mV rms from 1000 MHz to 1300 MHz

Input Impedance: 50Ω

VSWR: 2.5:1 maximum

Maximum Input: 5V rms, fuse-protected

## General Specifications

Display: 8-digit LED with leading zero suppression, decimal, and annunciators

Cycle Rate: Fixed 250 ms between readings

Reset: Reset button clears display, lights all display segments and, on release, activates a new measurement

Self Check: Counts and displays 10 MHz clock

Marker Output: TTL compatible output. Positive going edge indicates Channel A trigger, negative going edge indicates Channel B trigger. Typical delay from the time signal triggers input amplifier to the time marker changes level at rear panel output is 30 ns for the 7261A, 75 ns for the 7260A

Temperature: 0°C to 40°C, operating; -40°C to +70°C, non-operating

EMI: Internal metal RFI shield (tested to MIL-STD-461, Notice 3).

Safety: Designed to meet requirements of UL 1244 and IEC 348

Power: 100V, 120V, 220V or 240V  $\pm 10\%$ , 47 to 63 Hz, 32 VA max

Size: 32.7 cm L x 20.3 cm W x 10.8 cm H (12.9 in L x 8.0 in W x 4.3 in H)

Weight: 3 kg (6.5 lb)

Included: Instruction manual, power cord. Order Y9111 or Y9112 coaxial cable(s) separately

## Models

January 1985 prices

7260A Universal Counter/Timer .....	\$1245
7261A Universal Counter/Timer .....	1405

## Options

72XXA-010*	Rechargeable Battery Pack .....	415
72XXA-112*	TCXO, 2 ppm .....	235
72XXA-131*	Low Power Oven .....	285
72XXA-132*	Superior Low Power Oven .....	520
7261A-190**	Timebase Phase Modulation (7261A only) ....	180
72XXA-310*	50-520 MHz, Channel C .....	365
72XXA-331***	100-1300 MHz, Channel C .....	650
72XXA-521**	PTI Interface .....	180
72XXA-522K	Personality Card, for 1120A .....	205
72XXA-529 <sup>1</sup>	IEEE-488 Interface .....	365

\* Factory or Service Center installation only.

\*\* Factory option only.

\*\*\* Not compatible with Option -010. Also factory option only.

<sup>1</sup> Includes parts needed to interface the 7260A or 7261A to IEEE-488.

Parts can only be used in conjunction with Fluke 1120A IEEE-488 Translator. Includes 72XXA-521, 72XXA-522K, and Y7203 2 ft ribbon cable.

## Accessories (Also see page 230)

1120A IEEE-488 Translator .....	520
A53 Whip Antenna .....	25
Y7201 Attenuator/Filter .....	60
Y9111 3 ft (0.93m) Coaxial Cable, 50Ω .....	15
Y9112 6 ft (1.85m) Coaxial Cable, 50Ω .....	15
Y9103 50Ω Feed-thru Termination .....	30
Y2014 5/4" Rack Adapter, Single .....	90
Y2015 5/4" Rack Adapter, Double .....	90
Y2020 Panel Mounting Kit .....	90
Y7203 2 ft PTI Ribbon Cable .....	45
Y7204 5 ft PTI Ribbon Cable .....	60
Y2023 PTI Accessory Case .....	125

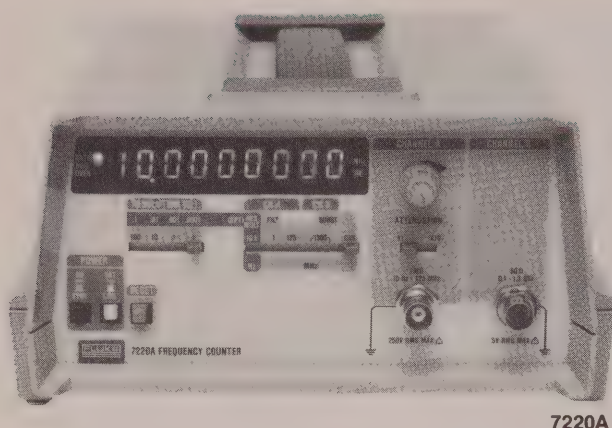
## After-Warranty Service (See page 227)

SC1-7260A, per 90-day interval .....	108
SC1-7261A, per 90-day interval .....	124



# COMMUNICATIONS COUNTER

7220A



7220A

## 7220A Communications Counter

- 9-digit display
- Channel A range: 10 Hz to 125 MHz
- Channel B range: 100 MHz to 1300 MHz
- Ac-coupled, 1 megohm input on Channel A, 50 ohm input Channel B
- Continuously variable X1 and X10 wideband attenuator
- Switchable 100 kHz low-pass filter
- Internal metal shielding

The 7220A gives you 10 Hz to 1300 MHz coverage via two separate channels. Channel A is for low-frequency applications (10 Hz to 125 MHz), where the loading of the signal source and the effects of high frequency noise must be minimized. Channel B has a 50 ohm input and is for signals from 100 MHz to 1300 MHz.

An ac-coupled, 1 megohm input and versatile front-end controls for Channel A let you measure signals having extremely high noise levels and still produce stable, accurate readings. A continuously variable X1 to X10 wideband attenuator plus switchable 1X or 10X attenuation lets you minimize noise without losing the signal. And a switchable 100 kHz low-pass filter solves the problem of high frequency contamination of audio frequencies. Used together, the attenuator and filter can solve most noise problems. Electromagnetic interference is greatly reduced with internal metal shielding to meet most of the requirements of U.S. Military Standard MIL-STD-461.

Housed in Fluke's Portable Test Instrument (PTI) case, the 7220A stacks and latches to any other PTI product to become part of a complete, one handle measurement system. The case easily comes apart for servicing.

## Resolution Multiplier

Option -351 increases measurement resolution by a factor of 1000 for frequencies from 10 Hz to 10 kHz without requiring any more measurement time. Resolution goes from 0.0001 Hz for 10 Hz signals to 0.1 Hz for 10 kHz signals.

## Ovenized Accuracy with Battery Portability

With Option -010, the 7220A may be operated away from ac line power. The internal rechargeable battery pack will provide power for 5½ hours for typical operation. For demanding field applications, the superior accuracy of optional ovenized oscillators assures the highest performance from your counter. These oscillators consume very little power in contrast to conventional ovenized oscillators, so may be used when the 7220A is operating from batteries. And, when you leave the lab on a field assignment, you can switch battery power to the oven to keep the oscillator warm and standing by for

measurements with maximum stability and accuracy. There are two low-power oven options to choose from — one (-131) with an aging rate of  $\pm 1 \times 10^{-7}$ /month and one (-132) with a superior aging rate of  $\pm 5 \times 10^{-8}$ /month. Also there is a low-cost conventional temperature-compensated crystal oscillator (TCXO) for superior accuracy (Option -111).

## IEEE-488 Compatibility

Using the Fluke 1120A Translator, a 7220A may be operated in a system configuration with other instruments compatible with IEEE Std 488-1978.

## Specifications

### Frequency Measurements

**Channel A Range:** 10 Hz to 125 MHz

**Channel B Range:** 100 MHz to 1300 MHz

**Resolution:** 0.1 Hz to 100 Hz in decade steps

**Accuracy:**  $\pm 1$  count  $\pm$  timebase error\*

**Display:** MHz

**Burst Mode:** Minimum burst equals gate time  $+40 \mu\text{s}$

### Channel A Input Characteristics

**Bandwidth:** 10 Hz to 125 MHz, ac-coupled

**Sensitivity:** 10 mV rms, 10 Hz to 50 MHz; 15 mV rms, 50 MHz to 100 MHz; 15 mV rms, 100 MHz to 125 MHz

**Impedance:** 1 M $\Omega$ ,  $<60 \text{ pF}$

**Filter:** 100 kHz, low-pass

**Attenuation:** X1 to X100; X1 or X10 fixed, plus X1 to X10 continuously variable

**Maximum Input:** 250V rms from 10 Hz to 5 kHz decreasing linearly from 250V rms at 5 kHz to 5V rms at 2 MHz; 5V rms from 2 MHz to 125 MHz

### Channel B Input Characteristics

**Bandwidth:** 100 MHz to 1300 MHz

**Sensitivity:** 5 mV rms, 100 MHz to 600 MHz; 10 mV rms, 600 MHz to 1000 MHz; 40 mV rms, 1000 MHz to 1300 MHz

**Impedance:** 50 $\Omega$

**VSWR:** 2.5:1, maximum

**Maximum Input:** 5V rms

### External Timebase

**Frequency:** 10 MHz

**Sensitivity:** 300 mV rms

**Input Impedance:** 1 k $\Omega$  shunted by 30 pF, ac-coupled

**Maximum Input:** 3V rms

**Output:** TTL-level 10 MHz squarewave, 200 $\Omega$ , nominal

### Timebase Characteristics

Characteristics	Option			
	Standard	-111 TCXO	-131 Oven	-132 Oven
Frequency	10 MHz	10 MHz	10 MHz	10 MHz
Aging Rate (Const. Temp)	$\pm 5 \times 10^{-7}$ /mo	$\pm 3 \times 10^{-7}$ /mo $\pm 1 \times 10^{-6}$ /yr	$\pm 1 \times 10^{-7}$ /mo*	$\pm 5 \times 10^{-8}$ /mo* $\pm 3 \times 10^{-9}$ /day*
Temperature Accuracy (0°C to 40°C)	$< 5 \times 10^{-6}$ **	$\pm 1 \times 10^{-6}$	$\pm 1 \times 10^{-7}$	$\pm 3 \times 10^{-8}$
Line Variation ( $\pm 10\%$ change)	$\pm 1 \times 10^{-7}$	$\pm 2 \times 10^{-7}$	$\pm 2 \times 10^{-8}$	$\pm 4 \times 10^{-9}$
Battery Operation	$\pm 1 \times 10^{-7}$	$\pm 2 \times 10^{-8}$	$\pm 5 \times 10^{-8}$	$\pm 1 \times 10^{-8}$
Warm-up***	—	—	$\pm 5 \times 10^{-7}$	$\pm 5 \times 10^{-7}$
10 Minutes	—	—	$\pm 3 \times 10^{-8}$	$\pm 3 \times 10^{-8}$
20 Minutes	—	—	—	—

\*After five days of continuous operation

\*\*Includes temperature variations during operation

\*\*\*Compared to frequency 24 hours after turn on

# COMMUNICATIONS COUNTER

7220A

## Option Specifications

### Battery Pack Option (-010)

**Type:** Nickel-Cadmium, size F

**Operating Time:** 5½ hours, typical operation

**Charge Time:** 16 hours at room temperature

**Charge Protection:** Thermistor-actuated shutdown of charging circuit if battery temperature is too high

**Discharge Protection:** Automatic shutdown prevents over-discharge

### PTI Interface (-521)

**Type:** Serial BCD output of all 9 digits, decimal, and measurement units

### Personality Card Option (-522K)

For 1120A IEEE-488 Translator. Part of Option -529

### IEEE-488 Interface Option (-529)

**Description:** Interfaces the 7220A to IEEE-488 bus via the Fluke 1120A IEEE-488 Translator. (1120A purchased separately). Provides full measurement output capability

**Repertoire:** SH1, AH1, T5, L4, SR1, RL2, DC1, DT1

### Resolution Multiplier Option (-351)

**Description:** Frequency-locked loop circuit designed to increase low frequency resolution 1000 times

**Range:** 10 Hz to 10 kHz

**Lock Time:** 1.5 seconds

**Resolution:** 0.0001 Hz to 0.1 Hz in decade steps

**Accuracy:**  $\pm 2$  counts  $\pm$  timebase accuracy\*

\*See timebase characteristics for timebase accuracy

## General Specifications

**Display:** Nine-digit LED

**Self-Check:** Counts and displays 10 MHz clock

**EMI:** Internal metal RFI shield meets most requirements of MIL-STD-461, notice 3

**Safety:** Designed to meet requirements of UL 1244 and IEC 348

**Power:** 100V, 120V, 220V, 240V ac  $\pm 10\%$  switch-selectable, 47 Hz to 63 Hz, 24VA maximum

**Size:** Style C PTI case, 32.7 cm L x 20.3 cm W x 10.8 cm H (12.9 in x 8.0 in x 4.3 in)

**Weight:** 3.2 kg (7 lb)

**Included:** Instruction manual, power cord. Order Y9111 or Y9112 coaxial cable(s) separately

## Model

January 1985 Prices

7220A 1300 MHz Frequency Counter ..... \$1300

## Options

72XXA-010*	Rechargeable Battery Pack	415
7220A-111*	1 ppm TCXO	180
72XXA-131*	Low-power Oven	285
72XXA-132*	Superior Low-power Oven	520
7220A-351*	1000X Resolution Multiplier	100
72XXA-521**	PTI Interface	180
72XXA-522K	Personality Card, for 1120A	205
72XXA-529 <sup>1</sup>	Interface for IEEE-488 bus	365

\* Factory or Service Center installation only

\*\* Factory option only

<sup>1</sup> This option can only be used in conjunction with the Fluke 1120A IEEE-488 Translator, purchased separately. Includes 72XXA-521, 72XXA-522K, and 2 ft ribbon cable (Y7203)

## Accessories (Also see page 230)

1120A	IEEE-488 Translator	520
A53	Whip Antenna	25
Y9111	3 ft (0.93m) Coaxial Cable, 50Ω	15
Y9112	6 ft (1.85m) Coaxial Cable, 50Ω	15
Y9103	50Ω Feed-thru Terminator	30
Y2014	5¼" Rack Adapter, Single	90
Y2015	5¼" Rack Adapter, Double	90
Y2020	Panel Mounting Kit	90
Y7203	2 ft PTI Ribbon Cable	45
Y7204	5 ft PTI Ribbon Cable	60
Y2023	PTI Accessory Case	125

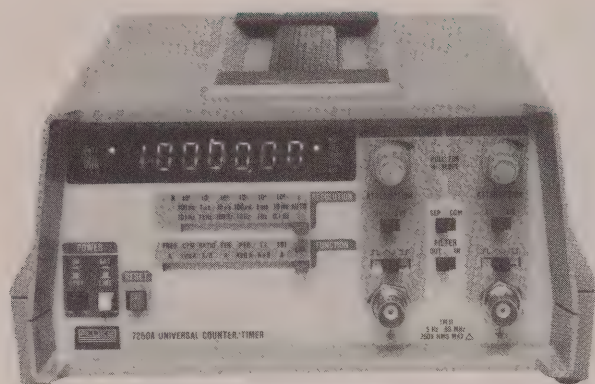
## After-Warranty Service (See page 227)

SC1-7220A, per 90-day interval ..... 92



# UNIVERSAL COUNTER/TIMER

## 7250A



7250A

### 7250A Universal Counter/Timer

- Frequency to 80 MHz
- Time intervals from 100 ns to 99,999.99 sec
- Period average range 1 ps to 999,999.9 ms
- Autorange
- Internal stainless steel shield

The 7250A Counter is the lowest priced model in the Portable Test Instrument (PTI) series. Its construction and features are much like those of the 7260A and 7261A.

The instrument will measure frequency to 80 MHz, time intervals down to 100 ns, and periods down to 100 ns with 1 ps resolution (in the average mode). In addition it will measure the ratio of two signal frequencies, counts per minute, or totalize events to 9,999,999 counts.

### Simple Operation

The 7250A lets you keep your hands and mind on the job instead of on the counter controls. Select the measurement function you want, set the resolution switch to **AUTORANGE** and the 7250A will automatically choose the correct range for best resolution with up to 7-digit display. It will then position the decimal point properly and light an annunciator LED to inform you of the unit of measurement.

### Controls You May Need

A broadband, continuously variable, x100, analog attenuator lets you add just enough attenuation to minimize the input signal noise level and optimize the signal amplitude for counting. A switchable 100 kHz, lowpass filter solves the problem of high frequency contamination of audio frequency signals. You can use the filter and attenuator separately or in combination to solve tough noise problems, like calibrating audio oscillators near high power rf transmitters. For timing measurements, there are  $\pm$ slope controls, fixed-offset trigger level switches, and a separate/common switch at your fingertips.

### Take It to the Job

The rugged case, compact design, and optional rechargeable battery pack means you can take the 7250A with you to solve those tough field service problems, with no sacrifice in performance. You can operate the counter continuously for up to 3.5 hours before recharging. And battery protection is foolproof. A relay provides positive protection against over-discharge and a thermistor sensor protects against charging when the batteries are too hot.

### Laboratory Accuracy in the Field

For applications demanding the best possible accuracy, optional ovenized oscillators are available. They consume very low power in contrast to conventional oscillators, so they can even be used when the 7250A is operating from batteries. When you go out on a field assignment, switch battery power to the oven before leaving and you will arrive with laboratory accuracy with a warm-up.

### Low Electromagnetic Interference

A lightweight, internal, stainless steel shield surrounds the instrument and mates with the metal front and rear panels to provide an enclosure meeting most requirements of MIL-STD-461. This means low susceptibility in high-rf environments as well as minimal radiated energy to interfere with nearby rf-sensitive equipment.

### IEEE-488 Compatibility, PTI Package

The 7250A incorporates the Fluke-developed portable test instrument (PTI) packaging concept which lets you easily configure low cost, convenient mini-test systems using the Fluke 1120A IEEE-488 Translator. The 7250A is rack-mountable with the 1120A when used with other equipment compatible with IEEE Std 488-1978.

### Specifications

#### Frequency Measurements (CH A)

Range: 5 Hz to 80 MHz, ac coupled

Resolution: 0.1 Hz to 10 kHz, in decade steps

Accuracy:  $\pm 1$  count  $\pm$  timebase error\*

Display: kHz or MHz with decimal

\*See Timebase Characteristics chart

#### Period Measurements (CH A)

Range: 100 ns to 99,999.99 seconds

Frequency Range: 5 Hz to 1 MHz

Resolution: 10 ms to 100 ns in decade steps

Accuracy:  $\pm 1$  count  $\pm$  timebase error  $\pm$  trigger error

Display: ms, or sec with decimal

#### Period-Average Measurements (CH A)

Range: 1 ps to 999,999.9  $\mu$ s

Frequency Range: 5 Hz to 1 MHz, sinewave

Resolution: 100 ns to 1 ps in decade steps

Accuracy:  $\pm 100$  ns  $\div$  N\*  $\pm$  timebase error  $\pm$  trigger error  $\div$  N\*

Display:  $\mu$ s or ms with decimal

\*N =  $10^0$  to  $10^5$  in decade steps set by resolution switch. Indicates the number of periods averaged in period average mode, the number of intervals averaged in time interval average mode, or the number of cycles of B averaged in ratio mode.

#### Time-Interval Measurements (CH A/CH B)

Range: 100 ns to 99,999.99 sec

Frequency Range: 5 Hz to 1 MHz

Resolution: 100 ns to 10 ms in decade steps

Accuracy:  $\pm 1$  count  $\pm$  timebase error  $\pm$  trigger error

Display: ms or sec with decimal

#### Totalize

Range: 5 Hz to 80 MHz for channel A

Count Capacity: 9,999,999

Display: Digits only, no decimal or annunciator

#### Ratio Measurements

Range: 5 Hz to 80 MHz for channel A, 5 Hz to 1 MHz for Channel B

Resolution:  $\pm$  frequency of B  $\div$  (N\* x frequency of A)

Accuracy:  $\pm$ Resolution  $\pm$ (frequency of B x trigger error of B  $\div$  N\*)

Display: Digits with decimal, no annunciator

# UNIVERSAL COUNTER/TIMER

7250A

## Counts Per Minute (cpm x 100,\* CH A)

Range: 5 Hz to 80 MHz

Count Time: 600 ms (1/100 minute)

Resolution: 100 cpm, fixed

Accuracy:  $\pm 1$  count  $\pm$  timebase error

Display: Digits only, no decimal or annunciator

\*Reads RPM direct of 100-tooth wheel/sensor

## Channel A & B Input Characteristics

Selection: Separate or A connected to B (Sep/Com)

Sensitivity: 10 mV rms 5 Hz to 50 MHz, 15 mV rms, 50 MHz to 80 MHz\*

Impedance: 1 M $\Omega$ , 50 pF, nominal

Coupling: ac only

Attenuator: X 1 X 100, continuously variable

Filter: 1 Low pass, 100 kHz 3 db point, nominal

Trigger Level: +150 mV, 0V, or -150 mV, switch-selectable

Maximum Input: 100V rms 5 Hz to 45 Hz, 250V rms 45 Hz to 50 kHz decreasing to 5V rms at 1 MHz, 5V rms 1 MHz to 80 MHz

## External Timebase Input

Frequency: 10 MHz, ac coupled

Sensitivity: 300 mV rms

Impedance: 1 k $\Omega$ , 30 pF, nominal

Maximum Input: 3V rms

## Timebase Characteristics

Same as for 7260A &amp; 7261A

## Option Specifications

### Battery Pack Option (-010)

Type: Nickel-Cadmium, size F

Operating Time: 3.5 hours continuous, decreasing to 3 hours, typical worst case with Option -131 or -132 ovenized oscillators installed

Charge Time: 16 hours at room temperature

Charge Protection: Thermistor-actuated shutdown of charging circuit if battery temperature exceeds 65°C

Discharge Protection: Automatic low-voltage shutdown to prevent over discharge

### PTI Interface (-521)

Type: Serial BCD output of all 7 digits and measurement units

Levels: TTL, "1" state low

### Personality Card Option (-522K)

For 1120A IEEE-488 Translator. Part of Option -529

### IEEE-488 Interface Option (-529)

Description: Interfaces the 7250A to IEEE-488 via the Fluke 1120A IEEE-488 Translator. (Note: 1120A must be purchased separately.)

Provides full measurement output capability, and limited triggering and reset of a measurement

Repertoire: SH1, AH1, L4, SR1, RL2, DC1, DT1

## General Specifications

Display: 7-digit LED with leading zero suppression, decimal, and annunciators

Cycle Rate: Fixed 250 ms between readings

Reset: Reset button clears display, lights all display segments and, on release, activates a new measurement

Self Check: Counts and displays 10 MHz clock

Temperature: 0°C to 40°C, operating; -40°C to +70°C, non-operating

EMI: Internal metal RFI shield meets most requirements of MIL-STD-461, Notice 3

Safety: Designed to meet requirements of UL 1244 and IEC 348

Power: 100V, 120V, 220V or 240V ac  $\pm 10\%$ , 47 to 63 Hz, 32 VA max.

Size: 40.3 cm L x 20.3 cm W x 10.8 cm H (12.9 in L x 8.0 in W x 4.3 in H)

Weight: 3 kg (6.5 lbs)

Included: Instruction manual, power cord. Order Y9111 or Y9112

coaxial cable(s) separately

## Model

January 1985 prices

7250A Universal Counter/Timer ..... \$990

## Options

72XXA-010*	Battery Pack, NiCd Rechargeable	415
72XXA-112*	TCXO, 2 ppm	235
72XXA-131*	Low Power Oven	285
72XXA-132*	Superior Low Power Oven	520
72XXA-521**	PTI Interface	180
72XXA-522K	Personality Card	205
72XXA-529 <sup>1</sup>	IEEE-488 Interface	365

\* Factory or Service Center installation only

\*\* Factory option only

<sup>1</sup> Includes parts needed to interface the 7250A to IEEE-488. Parts can only be used in conjunction with Fluke 1120A IEEE-488 Translator. Includes 72XXA-521, 72XXA-522K, and Y7203 2 ft ribbon cable.

## Accessories (Also see page 230)

1120A	IEEE-488 Translator	520
A53	Whip Antenna	25
Y7201	Attenuator/Filter	60
Y9111	3 ft (0.93m) Coaxial Cable, 50 $\Omega$	15
Y9112	6 ft (1.85m) Coaxial Cable, 50 $\Omega$	15
Y9103	50 $\Omega$ Feed-thru Terminator	30
Y2014	5/4" Rack Adapter, Single	90
Y2015	5/2" Rack Adapter, Double	90
Y2020	Panel Mounting Kit	90
Y7203	2 ft PTI Ribbon Cable	45
Y7204	5 ft PTI Ribbon Cable	60
Y2023	PTI Accessory Case	125

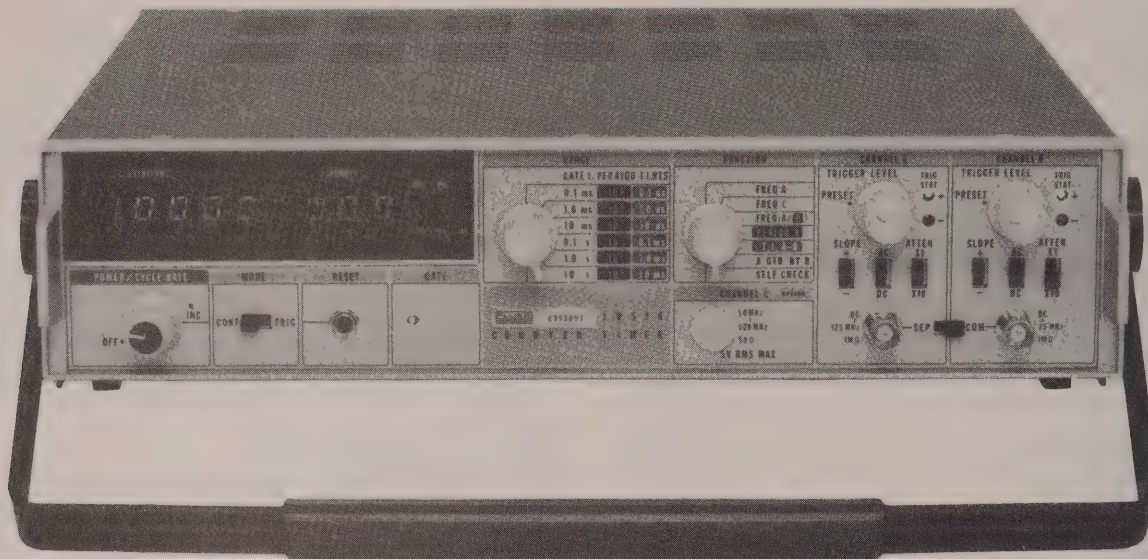
## After-Warranty Service (See page 227)

SC1-7250A, per 90-day interval ..... 96



# UNIVERSAL COUNTER/TIMER

1953A



1953A

## 1953A Universal Counter/Timer

- Frequency, frequency ratio, period, period averaging, time interval, gated totalize measurements
- 9 digit display
- Trigger level controllable on both channels
- Selectable + or — scope triggering, ac or dc coupling, X1 or X10 attenuation
- Switch selection of separate or common input between channels

The 1953A is Fluke's sophisticated system counter which has an outstanding price/performance ratio and a wide array of options which allow you to select just the capability you need to solve your specific measurement problems.

## Features

The standard instrument features all the basic functions required for a variety of measurements: frequency, frequency ratio, period, period averaging, time interval, and gated totalize. Wide-ranging provides six choices of gate times, period averages, and time interval resolutions. The 1953A counts to 125 MHz, higher with Option -07, -13, or -14.

The trigger-level controls for channels A and B allow the user to select a preset trigger level (0V dc) or to vary the level at which the input signal will trigger the counter. Two LED trigger status indicators operate in conjunction with each level control to show whether the counter is correctly triggered or when the input is more positive or negative with respect to the selected trigger level (see diagram). Two level output jacks allow a DMM to set the levels accurately.

Three signal conditioning switches are provided for each channel permitting the operator to select positive or negative slope triggering, ac or dc coupling, and X1 or X10 attenuation.

Dual input channels are direct coupled with 30 mV sensitivity. A switch for selection of separate or common input between channels is provided to allow input of either a single source common to both channels or two separate sources each on a separate channel. This is particularly useful in time interval measurements. A TTL marker pulse output permits accurate determination of the start and stop

signal trigger points. By connecting this marker pulse to an oscilloscope Z-axis input, the portion of the waveform displayed on the oscilloscope during the time interval measured will be intensity modulated.

A display check lights all digit segments when the reset button is pressed with the counter in self-check mode. A large, easy-to-read 9-digit LED display includes full leading zero suppression, automatic annunciation, and overflow.

## Options

Three 50Ω input prescalers are available to extend frequency measurement capability from 0 to 125 MHz (standard) to 520, 1000 or 1250 MHz. A superior TCXO and two oven stabilized timebases provide higher accuracy measurements. Available to systems oriented users is a choice of three remote programming options, two of the fast parallel controlled type and one using the bi-directional IEEE-488 interface. A separate parallel data output option is available for digit, decimal point, overflow, and units annunciation information for data acquisition use. All options are TTL compatible.

## IEEE-488 Interface Option

This interface permits interconnection with bus-compatible Fluke instruments and those of other manufacturers having the standard interface. The Fluke IEEE Interface Option (-15) is intended for systems applications where bus management and data manipulation are performed via a system controller (terminal, calculator, computer, etc.). The counter can also be manually operated without the use of a controller, displaying measurement information locally and outputting data (talk only mode) directly to a printer, display terminal or other peripheral device.

The 1953A Option -15 is compatible with the IEEE Interface standard using the preferred ASCII (U.S.A. Standard Code for information interchange) character-serial, seven bit code set. Interface driver and receiver circuits are all TTL compatible which permits remote operation of the counter's function, range, and signal conditioning, with front panel lockout.

Output information is comprised of 9 display digits, decimal point, and exponent for frequency or time units. Overflow indication is provided beyond a display of 10<sup>9</sup>.

Two internal D/A converters are included for remote programming of the A and B channel trigger levels. Each provides 1% resolution.

## UNIVERSAL COUNTER/TIMER

1953A

## Specifications

## Frequency Measurements

**Range:** 0 to 125 MHz (dc coupled) 5 Hz to 125 MHz (ac coupled). Prescalers to 1250 MHz (Options -07, -13, -14). All prescalers have clean dropout to eliminate false readings  
**Gate Time:** 0.1 ms to 10s in 6 decade steps (prescaled input increases gate time by a factor of 4 or 8)  
**Resolution:** 0.1 Hz at 10s gate time to 10 kHz at 0.1 ms gate time  
**Accuracy:**  $\pm$  Timebase accuracy  $\pm 1$  count  
**Readout:** kHz or MHz displayed with decimal point

## Period Measurements

**Range:** 0 to 25 MHz (dc coupled), 5 Hz to 25 MHz (ac coupled)  
**Periods Averaged:** 1 period to  $10^5$  periods in decade steps  
**Clock Frequency:** 10 MHz  
**Resolution:** 0.1  $\mu$ s at 1 period to 1 ps at  $10^5$  periods  
**Accuracy:**  $\pm 1$  count + timebase accuracy + trigger error of signal on input A\*  
**Readout:** ms or  $\mu$ s automatically displayed with decimal point  
*\*See Timebase Characteristics chart*

## Time Interval Measurements

**Range:** 0.1  $\mu$ s to  $10^5$ s  
**Input:** Channels A and B; common or separate  
**Resolution:** 10 ms to 0.1  $\mu$ s in 6 decade steps  
**Accuracy:**  $\pm 1$  count + timebase accuracy + trigger error\*  
**Readout:** ms or s automatically displayed with decimal point  
*\*See Timebase Characteristics Chart*

## Totalize Measurements

**Totalizing:** A gated by B  
**Range:** 0 to 125 MHz (dc coupled), 5 Hz to 125 MHz (ac coupled)  
**Readout:** Counts without annunciation or decimal point

## Ratio Measurements

**Display:** f1/f2, where f1 and f2 are applied at input channels A and B respectively  
**Range:**  
 f1: 0 to 125 MHz (dc coupled), 5 Hz to 125 MHz (ac coupled)  
 f2: 0 to 25 MHz (dc coupled), 5 Hz to 25 MHz (ac coupled)  
**Accuracy:**  $\pm 1$  count of signal on input A + trigger error of signal on input B\*  
**Readout:** Decimal point without unit annunciation  
*\*See Timebase Characteristics chart*

## Sensitivity

**Channel A:** 30 mV rms sinewave from dc to 75 MHz increasing to 50 mV at 125 MHz; 100 mV pulse amplitude with minimum pulse width of 10 ns  
**Channel B:** 30 mV rms sinewave from dc to 25 MHz; 100 mV with minimum pulse width of 50 ns  
**Channel C:** See Option -07, -13, -14

## Input Impedance

**Channel A or B:** 1 M $\Omega$ ,  $\leq 30$  pF  
**Channel C:** 50 $\Omega$  nominal

## Attenuator &amp; Limiting

**Channel A and B only:** Sensitivity is decreased by a factor of approximately 10 in the X10 position  
**Dynamic Range w/o Limiting:** -3.5 to +3.5V (Channel A and B) 1V rms (Channel C)  
**Impedance in Limiting Condition:** 120 k $\Omega$  in parallel with 75 pF (Channel A and B). VSWR less than 3:1 (Channel C)

## Slope &amp; Trigger Level

**Channel A and B only:** Front panel slide switch selects positive or negative slope triggering. Front panel control has  $\pm 1$ V range when attenuator is in X1 position, and  $\pm 10$ V in the X10 position  
**Maximum Input Voltage:** Channel A & B — 250V max dc + ac peak, 150V rms to 1 kHz; 5V rms to 125 MHz; Channel C — 5V rms, fuse protected  
**Trigger Level Output:** Channel A & B trigger levels available at rear panel BNC connectors

## Timebases

	Standard	-04 Option	-10 Option	-20 Option
Frequency	10.00 MHz	10.00 MHz	10.00 MHz	10.00 MHz
Aging Rate (Constant Temperature)	$\pm 3 \times 10^{-7}$ /mo 1 ppm/yr	$\pm 3 \times 10^{-7}$ /mo 1 ppm/yr	$\pm 1 \times 10^{-7}$ /mo	$\pm 1.5 \times 10^{-8}$ /mo
Temperature Accuracy 0°C-50°C	$\pm 2 \times 10^{-6}$	$\pm 5 \times 10^{-7}$	$\pm 1 \times 10^{-8}$	$< 7 \times 10^{-9}$ †
Line Voltage ( $\pm 10\%$ )	$\pm 2 \times 10^{-8}$	$\pm 2 \times 10^{-8}$	$\pm 3 \times 10^{-9}$	$\pm 1 \times 10^{-9}$

\* Trigger error of channels A or B is less than  $\pm 0.3\%$  of one period + periods averaged for signals with better than 40 dB signal to noise ratio and 100 mV rms amplitude

\*\* Trigger error in time interval mode is less than  $\pm 0.0025$ /signal slope (V/ $\mu$ s) in  $\mu$ s

† Peak to peak variation

## External Timebase Input

**Frequency Required:** 10 MHz  
**Sensitivity:** 250 mV  
**Impedance:** 1 k $\Omega$ , 20 pF  
**Dynamic Range w/o Limiting:** 8V peak to peak  
**Input Impedance During Limiting:** 470 $\Omega$  in parallel with 30 pF

## Option Specifications

## Digital Output Unit (-02)

Provides BCD TTL outputs from each digit, plus overflow, units annunciation, decimal point, and print command.

## Superior TCXO (-04)

See timebase specifications above

## Timebase Multiplier (-05)

Allows use of external 1, 5, or 10 MHz reference clock (standard unit accepts 10 MHz). This option also permits burst measurements to be made when a "level" signal is available

## Oven Stabilized Timebase (-10)

Oven is activated whenever instrument is connected to the AC line. See timebase specifications above

## Basic Parallel Remote Programming (-11)

Allows single-line programming (TTL or contact closure) of range, mode, slope, and reset functions. Allows analog programming of trigger levels, and provides power sense, overflow status, and system ready outputs. Front panel lockout is provided

## Full Parallel Remote Programming (-12)

Includes all the features of Option -11, plus programming of ac or dc coupling, attenuation, separate/common, and digital trigger level. Trigger level of channels A and B is programmable over a +1V to -1V range (2 BCD digits plus sign), giving a resolution of 1%, and an accuracy of 5% plus 2 mV (1 year). Temperature stability is better than 200  $\mu$ V/°C. Two analog input/output lines are provided for either checking the D/A performance, or programming via analog levels. Option -12 increases input capacitance to 37 pF maximum

## IEEE-488 Interface (-15)

Full remote programming of function, range, and all signal conditioning controls including trigger, coupling, slope, attenuator, and level. Directly compatible with IEEE-488-1978 Interface Standard. Data output includes 9 digits of display information, decimal point, and exponent for time or frequency units. Front panel lockout is provided. Ask for Application Bulletin 23.

## Rear Inputs (-16)

Two rear inputs in parallel with A and B front inputs (capacity 85 pF) plus a rear input for channel C (decreased sensitivities)



# UNIVERSAL COUNTER/TIMER

## 1953A

### Superior Oven-Stabilized Timebase (-20)

Oven is activated whenever instrument is connected to the AC line. See timebase specifications

### 520 MHz Channel C Input (-07)

Covers frequency range of 50 to 520 MHz, using a scaling ratio of 4. Sensitivity is 15 mV rms (AGC). Maximum allowable input is 5V rms (fuse protected). VSWR less than 2:1 into 50Ω for levels less than 1V rms

### 1000 MHz Channel C Input (-13)

Covers 50 to 1000 MHz using a scaling ratio of 8. Sensitivity is 15 mV rms, and maximum allowable input is 5V rms (fuse protected). VSWR is less than 2.5:1 for levels less than 1V rms.

### 1250 MHz Channel C Input (-14)

Covers 50 to 1250 MHz using a scaling ratio of 8. Sensitivity is 15 mV to 1000 MHz, decreasing to 30 mV rms at 1250 MHz. Maximum input is 5V rms (fuse protected). VSWR is less than 2.5:1 (50Ω) for levels less than 1V rms

## General Specifications

**Display:** 9-digit LED display with large 7-segment characters. Full leading zero suppression

**Cycle Rate:** In "CONT" mode, the time interval between successive measurements can be varied by means of a cycle rate control between approximately 0.2 and 2.0s. "Reset" button clears display and activates a new measurement

**Reset:** In "TRIG" mode, readings may be updated by pushing the "Reset" button or by grounding the external reset pin on the remote control connector. With external reset the display is not cleared

**Self-Check:** A timebase-derived 10 MHz signal is internally counted

**Gate Time:** High True, TTL level output

**Time Interval Marker:** Low True, TTL level output

**Temperature:** 0°C to +50°C, operating; -40°C to +75°C, non-operating  
**Power:** 115 or 230V ac  $\pm 10\%$  (100V operation available), 50 to 400 Hz, 30W nominal

**Size:** 8.8 cm H x 36.2 cm W x 34.3 cm D (3.45 in H x 14.25 in W x 13.5 in D)

**Weight:** 4.32 kg (9.5 lb)

**Included:** Instruction manual, power cord. Order Y9111 or Y9112 coaxial cable(s) separately

## Model

January 1985 prices

1953A Universal Counter/Timer ..... \$1660

## Options

1953A-02 Digital Output Unit .....	260
1953A-04* Superior TCXO .....	285
1953A-05 Timebase Multiplier .....	105
1953A-07* 520 MHz .....	520
1953A-10** Oven-Stabilized Timebase .....	415
1953A-11** Basic Remote Programming .....	310
1953A-12** Full Remote Programming .....	625
1953A-13* 1000 MHz .....	625
1953A-14* 1250 MHz .....	830
1953A-15*** IEEE-488 Interface .....	520
1953A-16** Rear Inputs .....	80
1953A-20** Superior Oven-Stabilized Timebase .....	780

\* Factory or Service Center installation only

\*\* Factory option only

\*\*\* Also factory option only. Cannot install with -02, -11, or -12

## Accessories (Also see page 230)

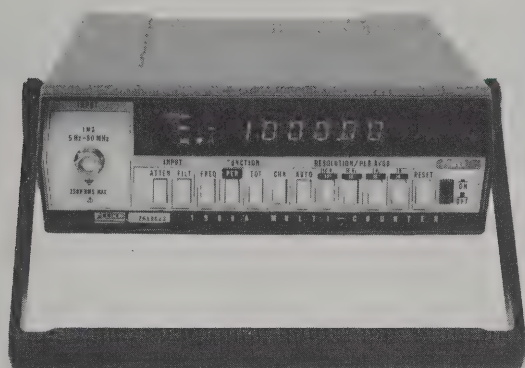
A53 Whip Antenna .....	25
Y7201 Attenuator/Filter .....	60
M00-200-622 3½" Rack Adapter .....	60
M00-200-626 3½" Rack Adapter w/slides .....	130
Y7206 3½" Adapter w/slides, for DEC cabinets .....	110
Y8021 1m Cable, IEEE-488 bus .....	85
Y8022 2m Cable, IEEE-488 bus .....	95
Y8023 4m Cable, IEEE-488 bus .....	105
Y9111 3 ft (0.93m) Coaxial Cable, 50Ω .....	15
Y9112 6 ft (1.85m) Coaxial Cable, 50Ω .....	15

## After-Warranty Service (See page 227)

SC1-1953A, per 90-day interval ..... 200

# MULTIFUNCTION COUNTER

Available through Distributors (See page 248) **1900A**



1900A

## 1900A Multifunction Counter

- Frequency, period, period averaging & totalize measurements
- 6-digit display
- 1 MHz low-pass filter
- Available with full parallel BCD output and rechargeable battery

Fluke's versatile 1900A Multi-Counter provides frequency, period, period averaging, and totalize measurements over a wide range of applications. In frequency mode, the 1900A verifies the accuracy of signal sources such as generators, oscillators and transmitters. Period mode measures the time duration of a single input cycle, which allows high resolution of low frequency measurements. In period average mode, the counter averages cycle time over 10, 100 or 1000 cycles for still finer resolution. Totalize mode is similar to frequency mode except that the signal gate is open and closed deliberately, a feature useful for totalizing the cycles in a single RF burst or counting electromechanical relay contact bounce. A selectable 1 MHz low-pass filter provides input signal conditioning to give accurate low frequency measurements in electrically noisy environments. A selectable 10:1 attenuator is provided.

A rechargeable battery is included in Model 1900A-01, providing up to 4 hours of operation with a 14 hour recharge time.

Digital data plus decimal point and annunciator data is available in Model 1900A-02. The full parallel BCD output in Model 1900A-02 is CMOS and TTL compatible and print command is provided.

## Specifications

**Frequency:** 5 Hz to 80 MHz. Four manually-selected gate times of 10 ms (100 Hz resolution), 100 ms (10 Hz resolution), 1s (1 Hz resolution), and 10s (0.1 Hz resolution). Autorange position automatically seeks to fill all 6 digits but will not select a gate time greater than 1s (1 Hz resolution)

**Period:** 5 Hz to 1 MHz. Manual selection of single period or 3 period-averaging ratios:

- 10<sup>0</sup> single period (100 ns resolution)
- 10<sup>1</sup> periods averaged (10 ns resolution)
- 10<sup>2</sup> periods averaged (1 ns resolution)
- 10<sup>3</sup> periods averaged (100 ps resolution)

Autorange position automatically seeks to fill all 6 digits but will not select a period average of greater than 10<sup>2</sup> averages

**Totalizing:** Accumulates up to 999999 counts, then activates overflow indicator

**Sensitivity:** 25 mV, typically 15 mV rms sinewave, 5 Hz to 80 MHz. Frequency and totalize: 200 mV peak-to-peak pulse amplitude with minimum pulse width of 20 ns. Duty cycle >10%. Period: 200 mV peak-

to-peak pulse amplitude with minimum pulse width of 200 ns. Duty cycle >10%

**Input Impedance:** 1 M $\Omega$ ,  $\leq$ 30 pF

**Noise Filter:** 1 MHz (3 dB point) lowpass

**Attenuator:** Decreases sensitivity by 10

**Overload:** 250V rms 5 Hz to 1 kHz decreasing to 20V at 80 MHz

**Timebase**

Frequency: 10.00 MHz

Aging Rate:  $\leq \pm 5 \times 10^{-7}$ /mo

Temperature Accuracy: 0°C to 50°C

Line Variation: ( $\pm 10\%$ )  $\leq \pm 1 \times 10^{-7}$

**Display:** 6-digit LED, leading zero suppression. Time between successive measurements is 200 ms plus measurement time.

**Annunciation:** MHz, kHz, ms,  $\mu$ s, overflow

**Autorange:** In both frequency and period modes, autoranging includes a unique 20% hysteresis in its switching thresholds to eliminate redundant up-range/down-range commands. This allows measurements to be made on signals containing large amounts of FM and  $\phi$ M. Hysteresis memory can be reset by depressing the "Reset" button

## General Specifications

**Autoreset:** A new measurement sequence is started every time a front panel button is activated

**Temperature:** 0°C to +50°C operating (40°C max in battery version if being charged while operating); -40°C to +60°C, non-operating

**Power:** 115 or 230V ac  $\pm 10\%$  (100V ac available) 50, 60 or 400 Hz. 6.5W line model, 8.5W battery model

**Fuses:** 1/8A line version, 1/2 amp slow-blow battery version

**Size:** 6 cm H x 22 cm W x 25 cm D (2.5 in H x 8.5 in W x 10 in D)

**Weight:** 1.2 kg (2.75 lb), 1.9 kg (4¼ lb) with batteries

**Included:** Instruction manual, power cord. Order Y9111, Y9112, and Y9103 coaxial cable(s) and 50-Ohm Terminator separately

## Models

January 1985 prices

1900A Multifunction Counter .....	\$410
1900A-01 With Rechargeable Battery .....	465
1900A-02 With Data Output .....	485

## Accessories (Also see page 230)

A53 Whip Antenna .....	25
C86 Carrying Case, Molded Plastic .....	20
Y7201 Attenuator/Filter .....	60
Y8205 Soft Carrying Case w/shoulder strap .....	35
Y9111 3 ft (0.93m) Coaxial Cable, 50 $\Omega$ .....	15
Y9112 6 ft (1.85m) Coaxial Cable, 50 $\Omega$ .....	15
Y9103 50 $\Omega$ Feed-thru Terminator .....	30
M00-100-714 Dust Cover .....	10
M00-200-611 3½" Rack Adapter, Offset .....	35
M00-200-612 3½" Rack Adapter, Center .....	35
M00-200-613 3½" Rack Adapter, Dual .....	50

## After-Warranty Service (See page 227)

SC1-1900A, per 90-day interval .....	48
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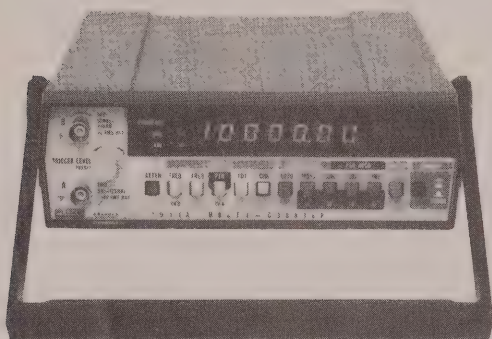


# MULTIFUNCTION COUNTERS

1910A/1911A/1912A Available through Distributors (See page 248)



1910A



1911A



1912A

## 1910A/1911A/1912A Multifunction Counters

- Frequency, period, period averaging & totalize measurements
- 7-digit display
- Autoranging
- Autoreset
- Instant warning when input signal falls below sensitivity threshold (Models 1911A and 1912A)
- Rechargeable battery pack version

These rugged counters are at home on the production line, in the lab, or in the field and do the work of counters costing much more. They measure frequencies to 125 MHz, 250 MHz or 520 MHz (depending on model), period of signals to 2 MHz, period average to 10 ps resolution and totalize to 9,999,999 counts.

## Autorange

Full autoranging is supplemented by selectable four-range manual operation. In autorange, the display is automatically filled to a maximum 7-digit readout. A unique hysteresis capability eliminates undesirable up-and-down ranging for between-range signals.

## Autoreset

This automatic feature is activated every time you select a new range or function, which means you never have to wait for a second reading, the first one in the new measurement sequence is always correct. Autoreset saves time and reduces errors.

## Automatic Clean Dropout

The 1911A and 1912A Channel B input has a circuit which automatically monitors the input and gives you instant warning in the form of zero readout whenever your input signal falls below the sensitivity threshold of the trigger circuit. When the signal level returns to an acceptable level, the counter locks on for a correct reading.

## Sensitivity

A basic sensitivity of 15 mV, backed by Fluke's conservative design margin, guarantees you will get reliable, solid readings every time. In practice, a typical sensitivity of 10 mV will be experienced.

## Versatile Timebases

The standard 0.5 ppm per month timebase assures excellent long term stability for bench, production or field use. A convenient rear panel external timebase input jack and switch let you operate from your own 10 MHz frequency standard at any time. Choice of optional timebases with improved aging rates and temperature stabilities allows you to purchase only as much stability as you'll need in your applications.

## Input Signal Conditioning

Each counter offers trigger level and attenuator controls which operate over the dynamic range of the input to permit accurate readings in the presence of noise. Even ringing TTL signals can be accurately measured. In addition, the 1911A offers a separate 50 ohm input for 50 MHz to 250 MHz and the 1912A does the same but goes to 520 MHz.

## Battery Portability

All three counters are available with rechargeable batteries for field portability. Order 1910A-01, 1911A-01, or 1912A-01. Four hours minimum operation gives you plenty of opportunity to solve those tough field service problems.

## Specifications

**Ch. A Attenuator:** X1, X10 (approx.)

**Ch. A Trigger Level:**  $\pm 0.5V$  range

**Ch. A Totalize:** 1 to 9,999,999 counts

**Frequency Accuracy:** Timebase accuracy  $\pm 1$  count

**Period Accuracy:** Frequency accuracy plus trigger error\*

\* Trigger error is less than 0.3% of one period  $\div$  periods averaged for sinewaves of 40 dB signal-to-noise ratio or better and amplitude equal to sensitivity of counter

**Frequency Resolution:** 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, manually selected. Autorange automatically seeks to fill 7 digits but will not select gate time  $> 1$  second

**Period Resolution:** 100 ns,  $10^0$  single period; 10 ns,  $10^1$  period averaged; 1 ns,  $10^2$  periods averaged; 100 ps,  $10^3$  periods averaged. Autorange automatically seeks to fill 7 digits; if input frequency is high enough, may select  $10^4$  periods averaged (10 ps resolution) but will not select measurement time  $> 1$  second

# MULTIFUNCTION COUNTERS

Available through Distributors (See page 248) **1910A/1911A/1912A**

## Specifications

Model	Channel	Operating Range		Sensitivity	Input Impedance	Overload (Max Input Voltage)	Prescale Factor
		Frequency	Period				
1910A	A	5 Hz - 125 MHz	500 ns - 0.2s (5 Hz - 2 MHz)	15 mV rms, 5 Hz - 100 MHz 25 mV rms, 100 MHz - 125 MHz	1 M $\Omega$ /30 pF, ac coupled	dc + ac; <360V pk ac; 250V rms 5 Hz - 1 kHz, 10V rms above 1 kHz	—
1911A	A	5 Hz - 125 MHz	500 ns - 0.2s (5 Hz - 2 MHz)	15 mV rms, 5 Hz - 100 MHz 25 mV rms, 100 MHz - 125 MHz	1 M $\Omega$ /30 pF, ac coupled	dc + ac; <360V pk ac; 250V rms 5 Hz - 1 kHz, 10V rms above 1 kHz	—
	B	50 MHz - 250 MHz	—	15 mV rms, 50 MHz - 175 MHz 30 mV rms, 175 MHz - 250 MHz	50 $\Omega$ , VSWR <2.5:1	dc + ac; <100V ac; 5V rms, fuse protected	2
1912A	A	5 Hz - 125 MHz	500 ns - 0.2s (5 Hz - 2 MHz)	15 mV rms, 5 Hz - 100 MHz 25 mV rms, 100 MHz - 125 MHz	1 M $\Omega$ /30 pF, ac coupled	dc + ac; <360V pk ac; 250V rms 5 Hz - 1 kHz, 10V rms above 1 kHz	—
	B	50 MHz - 520 MHz	—	15 mV rms, 50 MHz - 175 MHz 25 mV rms - 520 MHz	50 $\Omega$ , VSWR <2.5:1	dc + ac; <100V ac; 5V rms, fuse protected	4

## Option Specifications

### Data Output Option (-02)

**Data Output:** 7 digits with overflow, decimal point and units information in BCD parallel/byte serial format at CMOS levels

**Other Outputs:** 7-digit strobe signals, update signal, leading zero suppression signal

### TCXO Options (-03, -04)

See Timebase Selection Guide

### Timebase Selection Guide

Type (10 MHz)	Aging Rate	Line Variation ( $\pm 10\%$ )	Temperature Accuracy
			0 - 50°C
Standard	$\pm 5 \times 10^{-7}$ /mo	$\pm 1 \times 10^{-7}$	$\pm 5 \times 10^{-6}$ *
Option -03	$\pm 3 \times 10^{-7}$ /mo	$\pm 2 \times 10^{-8}$	$\pm 2 \times 10^{-6}$
Option -04	$\pm 3 \times 10^{-7}$ /mo	$\pm 2 \times 10^{-8}$	$\pm 5 \times 10^{-7}$

\*p-p variation

## Y7201 Attenuator/Filter

The Y7201 is a combination variable attenuator and selectable low pass filter which can be used for input signal conditioning on all counters. Typical specifications are:

**Input Impedance:** 47 k $\Omega$

**Attenuation Range:** X5 to X100, continuously adjustable

**Low Pass Filter:** 1 kHz, 20 kHz or 100 kHz, switch-selectable

**Maximum Input:** 30V AC

## General Specifications

**Display:** 7-digit LED, leading zeros suppressed

**Annunciation:** MHz, kHz, msec,  $\mu$ sec, overflow

**Operating Temperature:** 0°C to 50°C (line models). 0°C to 40°C (battery models) when operating and charging

**Storage Temperature:** -40°C to +70°C (line models). -40°C to +60°C (battery models)

### External Timebase Input

**Frequency:** 10 MHz to 300 kHz (typical)

**Amplitude:** 300 mV rms, 5V p-p max

**Input Impedance:** >1 k $\Omega$

**Power, Line Models:** 100, 115, or 230V ac  $\pm 10\%$ , 48 Hz to 440 Hz, 8 W maximum

### Power, Battery Models

100V  $\pm 10\%$ , 48 Hz to 52 Hz, 8.5W max

100V  $\pm 10\%$ , 58 Hz to 62 Hz, 8.5W max

115V  $\pm 10\%$ , 58 Hz to 62 Hz, 8.5W max

230V  $\pm 10\%$ , 48 Hz to 52 Hz, 8.5W max

*Note: Voltage and frequency must be specified at time of order*

**Time (between successive measurements):** 200 ms plus measurement time

**Size:** 6.4 cm H x 21.7 cm W x 27.1 cm D (2.52 in H x 8.55 in W x 10.65 in D)

**Weight:** 1.5 kg (3.2 lb) max, for line models. 2.2 kgm (4.8 lb) max for battery models

**Included:** Instruction manual, power cord. Order Y9111 or Y9112 coaxial cable(s) separately

## Models

January 1985 prices

1910A 125 MHz Multifunction Counter	\$570
1910A-01 With Rechargeable Battery	620
1911A 250 MHz Multifunction Counter	675
1911A-01 With Rechargeable Battery	725
1912A 520 MHz Multifunction Counter	825
1912A-01 With Rechargeable Battery	935

*Specify line voltage and frequency if other than 60 Hz and 115V ac*

## Options for 1910A, 1911A, 1912A

1910A-02* Data Output	50
1910A-03** 2 ppm TCXO	170
1910A-04** 0.5 ppm TCXO	285

\*Not compatible with battery models. Factory option only.

\*\*Factory option only

## Accessories (Also see page 230)

A53 Whip Antenna	25
Y7201 Attenuator/Low Pass Filter	60
Y9111 3 ft (0.93m) Coaxial Cable, 50 $\Omega$	15
Y9103 50 $\Omega$ Feed-thru Terminator	30
C86 Carrying Case, Molded Plastic	20
Y8205 Soft Carrying Case w/shoulder strap	35
M00-200-611 3½" Rack Adapter, Offset	35
M00-200-612 3½" Rack Adapter, Center	35
M00-200-613 3½" Rack Adapter, Dual	50

## After-Warranty Service (See page 227)

SC1-1910A, per 90-day interval	44
SC1-1911A, per 90-day interval	48
SC1-1912A, per 90-day interval	64





## Introduction

Fluke markets two models of Frequency Synthesizers and four models of Synthesized Signal Generators. They are cost effective, state-of-the-art instruments which excel in automated or manual testing of HF, VHF and UHF devices, and weapons systems. The generators frequency range is from 10 Hz to 1050 MHz, with IEEE-488, RS-232-C or ASCII system control.

## Signal Generator Selection Guide

Features	6070A	6071A	6060A	6011A	6160B	6039A/AZ
Frequency Upper Lower Resolution	520 MHz 200 kHz 1 Hz	1040 MHz 200 kHz 2 Hz >520 MHz	1050 MHz 100 kHz 10 Hz	11 MHz 10 Hz 0.1 or 10 Hz	160 MHz 1 MHz 0.1 or 1 Hz	40 MHz 1 MHz 0.1 or 1 Hz
Switching Time	35 ms to 85 ms	35 ms to 85 ms	<100 ms	2 ms to 34 ms	<800 $\mu$ s	N/A
Output Upper  Lower Resolution	+19 dBm  -140 dBm 0.1 dB	+13 dBm <520 MHz +19 dBm >520 MHz -140 dBm 0.1 dB	+13 dBm -137 dBm 0.1 dB	+27 dBm -55 dBm 0.01 dBm	+ 13 dBm +3 dBm Continuously Variable	+13 dBm +3 dBm
Spectral Purity (dBc) Harmonics Sub-Harmonic Spurs Line Spurious Non-Harmonic Spurs Phase Noise (20 kHz Offset at 500 MHz)	<-30 dBc — <-56 dBc <-90 dBc <-132 dBc	<-30 dBc <-35 dBc <-50 dBc <-84 dBc <-132 dBc	<-30 — — <-60 -107 (typ.)	<-50 — — <-60 -102 @ 10 MHz	<-30 — — <-83 <-121 @ 160 MHz	<-30 — — <-80 <-115 @ 4 MHz
Modulations Type AM FM $\phi$ M Int. Mod. Freq. Simultaneous Mod.	Yes Yes Yes 20 Hz to 200 kHz Yes	Yes Yes Yes 20 Hz to 200 kHz Yes	Yes Yes No 400 & 1000 Hz Yes	Yes Opt. No None No	N/A	N/A
Programming	IEEE-488 Standard	IEEE-488 Standard	IEEE-488 Optional	BCD Standard IEEE-488 or RS-232-C Optional	BCD Standard IEEE-488 Optional	N/A
Reverse Power Protection	Optional 50W	Optional 50W	Optional 50W	No	No	No
RFI	3 $\mu$ V	3 $\mu$ V	1 $\mu$ V	—	—	—
Relative Ampl. & Freq.	Yes	Yes	Yes	No	No	No
Volatile Memory	Std. (9 ea.)	Std. (9 ea.)	Std. (7 ea.)	Std. (9 ea.)	No	No
Non-Volatile Memory	Opt. (50 ea.)	Opt. (50 ea.)	Opt. (50 ea.)	No	No	No
Digital Sweep	Yes	Yes	No	No	No	No
Audio Output	Yes	Yes	No	No	No	No



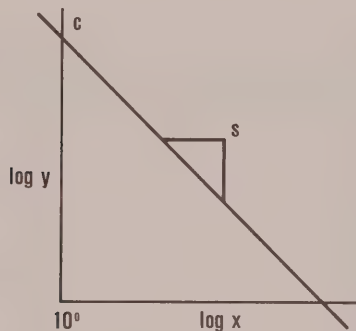
# SIGNAL GENERATORS

## Working From Graphed Phase Noise Data

Phase noise data for signal generators is often presented in graphical form, but sometimes one would like to express the same information in an equation, so that it could be manipulated mathematically. Here's how it's done:

The technique is to fit straight-line segments to the phase noise curve, and write equations for the line segments.

Equations of the form  $y = cx^s$  plot as straight lines on log-log graph paper. The equation can be written by inspection: the constant,  $c$ , is the value of  $y$  for which  $x = 1$ , and the exponent,  $s$ , is the slope of the line.



To use this method with a phase noise plot, draw a line tangent to the curve in the area of interest, then extend the vertical axis so that the value at 1 Hz can be read. Record this value (in dBc/Hz), and the slope of the line (in dB/decade). The constant,  $c$ , is the 1 Hz intercept value divided by ten, and the exponent is the slope divided by ten. The division by ten follows as a result of the vertical scale having the units, dB, which is  $10 \log (P_n/P_c)$ , rather than being just the log of  $P_n/P_c$ .

Intercept = + 19 dBc.

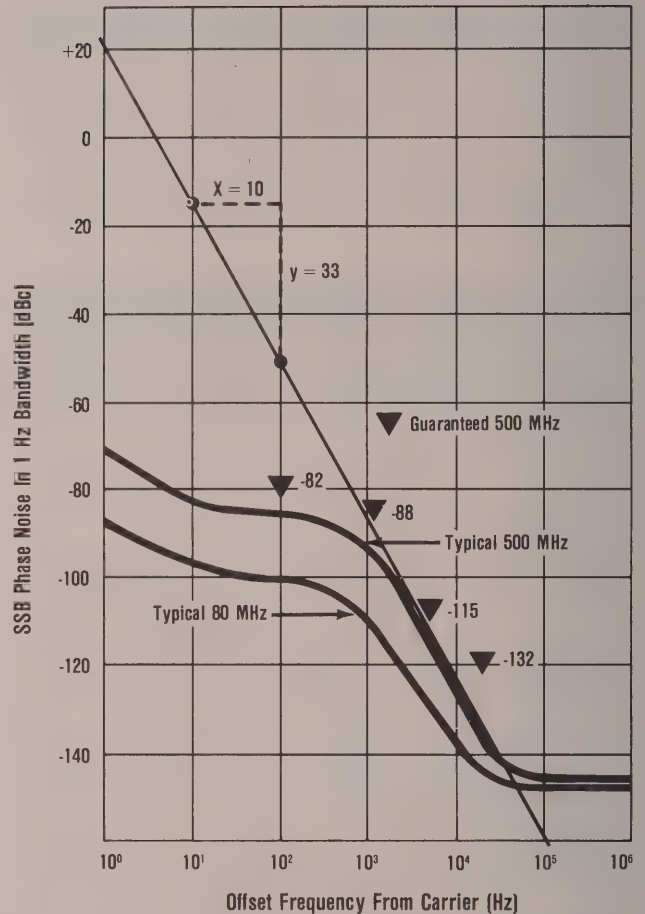
Slope = -33 dB./decade

therefore:  $c = 10^{+1.9}$   $s = -3.3$

And the equation is:  $\mathcal{L}(f_m) = 10^{+1.9} f_m^{-3.3}$

(Valid for  $f_m$  between 2 kHz and 30 kHz.)

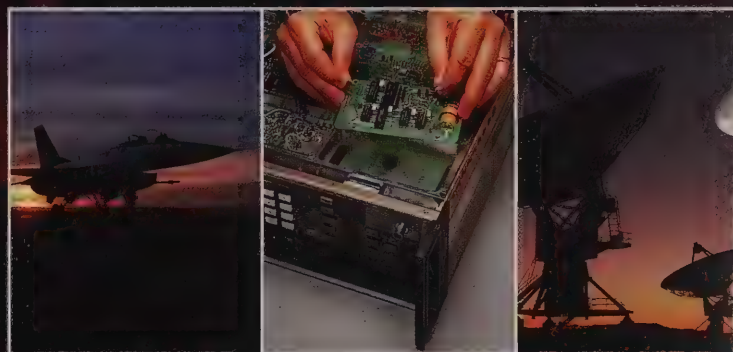
This equation is used to determine residual phase modulation and residual frequency modulation over a specific frequency band offset from the carrier.



# 6062A

Fluke 6062A Synthesized Signal Generator

■ 0.1 to 2100 MHz ■ IEEE-488 ■ AM, FM, PM ■ Pulse Modulation





# Precisely calibrated, RF signals for LF through L-Band.

The 6062A satisfies testing requirements for modern avionics, communications, radar, and navigation systems.

## Economy and Quality in a 2.1 GHz Signal Generator

The Fluke 6062A provides IEEE-programmable, precisely calibrated signals covering 0.1 to 2100 MHz.

Amplitude is programmable from -147 dBm to +16 dBm in 0.1 dB steps. Reverse power protection of the output is standard.

Modulation capabilities include AM, FM, phase modulation, and high-speed pulse modulation.

The instrument's usefulness is enhanced by non-volatile memory that provides storage for up to 50 front-panel settings. Its memory also stores useful service data, including logging of running time, number of attenuator operations, and diagnostic codes.

The 6062A introduces new supportability choices. It is backed by Fluke's convenient Module Exchange program. Additionally, it can be fully recalibrated on site, either manually or using new automated calibration routines.

The 6062A's design is an extension of the proven techniques used in the Fluke 6060B. Its innovative, efficient design, matched by quality construction, guarantees a reliable, and cost-effective instrument.

## Abbreviated Specifications:

### Frequency

Range: 0.1 to 2100 MHz

Resolution: 10 Hz (20 Hz above 1050 MHz)

### Reference Oscillator

Stability:  $\pm 5$  ppm, 0-50°C. (standard free-air crystal)

$\pm 1 \times 10^{-7}$ /mo. (-132 option, oven oscillator)

$\pm 5 \times 10^{-10}$ /day (-130 option, high-stability oven oscillator)

### Amplitude

Range: +16 to -147 dBm to 1050 MHz

+13 to -147 dBm above 1050 MHz

Accuracy:  $\pm 1.5$  dB (1 to 1050 MHz, +16 to -127 dBm)

$\pm 1.0$  dB 25°C  $\pm 5$ °C

$\pm 1.5$  dB (1050 to 2100 MHz, +13 to -127 dBm)

### Spectral Purity

Spurious: -60 dBc to 1050 MHz

-54 dBc above 1050 MHz

Harmonics: -30 dBc,  $\leq 13$  dBm

Subharmonic: -50 dBc

Residual FM at 500 MHz: 5 Hz rms (CCITT)

6 Hz rms (.3 to 3 kHz BW)

9 Hz rms (.05 to 15 kHz BW)

Typical SSB Phase Noise at 20 kHz offset... 500 MHz: -122 dBc/Hz

1000 MHz: -116 dBc/Hz

2000 MHz: -110 dBc/Hz

### John Fluke Mfg. Co., Inc.

P.O. Box C9090, Everett, WA 98206

Tel. 206-347-6100

For more product information —  
or where to buy Fluke products call:  
800-426-0361 (toll free) in most of U.S.A.  
206-356-5400 from AK, WA  
206-356-5500 from other countries

### Fluke (Holland) B.V.

P.O. Box 2269, 5600 CG

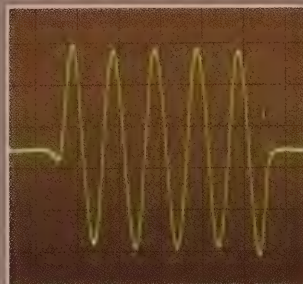
Eindhoven, The Netherlands

(040) 458045. TLX: 51846

Phone or write for the name of  
your local Fluke representative.

# 6062A

## Fluke 6062A Synthesized Signal Generator



50 nanosecond pulse, five cycles  
of 100 MHz.

### Fast-Rise Pulse Modulation

A gallium arsenide pulse modulator generates fast, high quality pulses for testing of pulsed communication and navigation circuits. It accommodates pulse repetition rates from 0 to 16 MHz. Its 15 nanosecond rise/fall time enables it to generate very narrow pulses.

### Modulation

AM: 0-99%

FM: to 400 kHz peak deviation

PM: to 40 Radians peak deviation

### Pulse Modulation (10 MHz to 2100 MHz)

On/Off ratio: 80 dB minimum

Rise and Fall time: 15 nanoseconds maximum

Repetition Rate: Dc to 16 MHz

Duty cycle: 0-100%

For more information and complete specifications on the 6062A Synthesized Signal Generator and other 6060 series signal generators, contact your local Fluke sales engineer, or call 1-800-426-0361.



## SYNTHESIZED SIGNAL GENERATOR

6060A

NEW



6060A

## 6060A Synthesized Signal Generator

- 100 kHz to 1050 MHz, 10 Hz resolution
- -137 to +13 dBm output, 0.1 dB resolution
- AM and FM, internal and external
- Non-harmonic spurious products less than -60 dBc and harmonics less than -30 dBc
- Built-in diagnostics and error code display
- IEEE-488
- Reverse power protection (optional)
- Non-volatile memory
- Relative frequency and amplitude modes

## Low Cost, High Performance

The Fluke 6060A is a fully programmable, synthesized signal generator covering 0.1 to 1050 MHz. It is designed for applications which require good modulation, frequency, and output level performance with moderate spectral purity for a low price. The 6060A is well suited for testing a wide variety of RF receivers (particularly in-band), and RF devices, such as filters, amplifiers, and mixers.

## Performance Summary

The 6060A has the capabilities needed for in-band RF testing. Output frequencies from 100 kHz to 1050 MHz are selectable with 10 Hz resolution. Non-harmonic spurious products are less than -60 dBc and harmonics less than -30 dBc across the entire frequency range. Levels, adjustable from -137 dBm to +13 dBm, can be selected with 0.1 dB resolution.

Amplitude and frequency modulation is standard. Simultaneous internal and external modulation is also standard. A special low-rate, ac-coupled external FM capability can be ordered as a special option.

## IEEE-488 Compatible Interface Option

All 6060A functions are accessible via the optional IEEE-488 interface option. The 6060A can process a command string, update the signal output accordingly, and settle in less than 100 ms. A "talk-only" feature is provided as well.

Using the IEEE-488 interface, multiple 6060As can be set to track one another in amplitude, frequency, or modulation in a master/slave configuration. As the front panel step-up or step-down key is pressed on the master instrument, the other 6060As will follow. This process streamlines frequency tracking applications such as mixer testing, and amplitude tracking applications like two-tone intermodulation tests.

## Operational Features

A built-in microprocessor handles all the operational functions, whether from the front panel or the IEEE-488 interface. These functions include:

**Keyboard Parameter Entry and Fluke Bright-digit Editing.**

**Increment Step Function**, to allow an operator to vary frequency, amplitude, or modulation in specific increments.

**Memory Store and Recall**, for seven complete front panel set-ups (50 set-ups with the non-volatile memory option).

**Relative Amplitude** allows compensation for cable losses in test set-ups.

**Relative Frequency** speeds testing of frequencies relative to a reference, during filter testing or receiver selectivity measurements.

## Self-Test Capability

Built-in diagnostics and error code displays provide immediate feedback of incorrect operation. Also, the 6060A performs a series of internal digital and analog tests at power-up and isolates problem areas immediately via a coded display on the front panel. These internal checks may be accessed and initiated at any time from the front panel. Special service and troubleshooting test routines are contained within the unit to aid in calibration and maintenance.

## Options Summary

Along with the IEEE-488 option, there are several other options to choose from to help tailor the 6060A to fit unique application requirements. The 6060A has a reverse power protection option (Option 870) rated at 50 watts and 50V dc; a high stability reference (Option 130) with  $\pm 5 \times 10^{-10}$ /day aging rate; a non-volatile memory option (Option 570) to store up to 50 separate front panel settings; a rear only RF output option (Option 830); and a sub-harmonic reference option (Option 131).



## SYNTHESIZED SIGNAL GENERATOR

6060A

## Specifications

## Frequency

**Frequency Range:** 0.1 to 1050 MHz. Output frequency is displayed on an 8½-digit display

**Frequency Resolution:** 10 Hz

**Switching Speed:** <100 msec typical (within ±100 Hz of selected value)

**Frequency Accuracy:** Referenced to internal free-air 10 MHz crystal oscillator, <±0.5 ppm/month; <±5 ppm for 25°C ±25°C (see also Option 130). Internal 10 MHz reference TTL signal available at rear panel (see also Option 131)

## Amplitude

**Amplitude Range:** -137 to +13 dBm (+13 dBm peak on AM), with overrange to -147 and +19 dBm, displayed on a 3½-digit display. Fixed-range output, selected by special function, allows more than 12 dB of vernier without attenuator switching

**Amplitude Resolution:** 0.1 dB. Annunciators for dB, dBm, V, mV, and  $\mu$ V provided on the display

**Switching Speed:** <100 msec typical (within 0.1 dB of selected value)

**Amplitude Accuracy:** ±1.5 dB 0.4-1050 MHz

**Output Impedance:** 50 ohms, nominal

**Output SWR:** <2.0; <1.5 below 1 dBm ≥400 kHz

## Spectral Purity

**Spurious:** <-60 dBc for offsets greater than 10 kHz

**Harmonics:** <-30 dBc

**Residual FM** (0.3 to 3 kHz band): <13 Hz rms from 245 to 512 MHz; <27 Hz rms elsewhere

**Residual FM** (0.05 to 15 kHz band): <30 Hz rms from 245 to 512 MHz; <60 Hz rms elsewhere

**Residual AM:** <0.1% rms (-60 dBc) in 0.05 to 15 kHz band

## Amplitude Modulation

**Depth Range:** 0 to 99%, with 1% resolution (displayed on 2-digit front panel display)

**Accuracy:** ±(2% + 4% of setting), for 0.1 to 3 kHz rates, depths to 90%, and peak amplitude of +13 dBm

**Distortion:** <2% THD, to 30% AM; <3% THD, to 70% AM; <5% THD, to 90% AM

**Bandwidth:** 20 Hz to 30 kHz, 3 dB

**Incidental FM:** <0.3 f<sub>m</sub> for internal rates and 30% AM

## Frequency Modulation

**Deviation Ranges:** 100 to 999 Hz; 1 to 9.99 kHz; and 10 to 99.9 kHz (displayed on 2-digit front panel display)

**Maximum Deviation:** Lesser of 99.9 kHz and 2f<sub>mfo</sub> above 245 MHz, or 2f<sub>m</sub>(f<sub>o</sub>+800) below 245 MHz, where f<sub>o</sub> is in MHz and f<sub>m</sub> in kHz (f<sub>o</sub>-100)/3 kHz below 0.4 MHz [f<sub>o</sub> in kHz]

**Accuracy:** ±7% for rates of 0.3 to 20 kHz (0.3 to 1 kHz for f<sub>o</sub> <0.4 MHz)

**Distortion:** <1% THD for rates of 0.3 to 20 kHz (0.3 to 1 kHz for f<sub>o</sub> <0.4 MHz) and >100 Hz deviation

**Bandwidth:** 0.02 to 100 kHz, 3 dB unspecified for f<sub>o</sub> <0.4 MHz

**Incidental AM:** <1% AM at 1 kHz rate

## Modulation Source

**Internal:** 400 Hz and 1 kHz, ±3% for 20°C to 30°C (add ±0.1%/°C outside this range). Selectable from the front panel

**External:** 1 volt peak input (MOD IN BNC) provides indicated modulation index. Input impedance = 600 ohms, nominal

**Modes:** INTAM; INTFM; EXTAM; EXTFM; INTAM and FM; EXTAM and FM; and INT(AM and/or FM) and EXT(AM and/or FM), in all nine combinations. Input impedance = 560 ohms, nominal, when EXTAM and FM are both enabled

## Option Specifications

All options are factory installable, only.

## High Stability Reference Option (-130)

**Aging Rate:** <±5 × 10<sup>-10</sup>/day, after 21 days

**Temperature Stability:** <±2 × 10<sup>-10</sup>/°C. Oven remains powered during standby

**Installation:** Mounts inside rear panel; includes auxiliary power supply

## Sub-Harmonic Reference Option (-131)

**Input:** 1, 2, 2.5, 5, and 10 MHz, 0.3 to 4V p-p, sine or squarewave into 50 ohms (nominal)

**Input Connector:** Additional BNC on rear panel, labeled REFIN (10 MHz IN/OUT is relabeled 10 MHz OUT)

## IEEE-488 Compatible Interface Option (-488)

**Functions:** All front panel controls except the power switch are programmable via the IEEE-488 interface. Instrument status is also available remotely. Store/recall memory may be accessed via an external controller. The memory data can be reloaded into the 6060A without modification. In the "talk-only" mode, the appropriate commands are output to control another 6060A, 6070A, or 6071A when the front panel step-up or step-down keys are pressed or activated. The 6070A and 6071A only have Frequency Step control.

The 6060A supports the following IEEE-488 functions SH1, AH1, T5, L3, SR1, RL1, PP0, DC1, DT1, C0, E2

## Non-Volatile Memory Option (-570)

**Description:** Up to 50 front panel control settings can be retained for 2 years. Battery power is used when the 6060A is in standby or the power cord is not attached.

## Reverse Power Protection Option (-870)

**Protection Level:** Up to 50 watts from a 50 ohm source or 50V dc, from 0.1 to 1050 MHz (dc blocking capacitor at output)

**Trip/Reset:** Flashing RFOFF annunciator indicates a tripped condition. Pushing RFON/OFF button on front panel will reset the output. Protection is not provided when the instrument is in off

## Rear RF Output and MOD Input Option (-830)

**Description:** Moves front panel RF OUTPUT and MOD INPUT connectors to the rear panel

## Low-Rate AC-Coupled External FM Option (-651)

**Maximum Deviation:** 10 kHz

**Droop:** 15% typical on a 10 Hz squarewave

**Bandwidth:** 0.5 Hz to 100 kHz, 3 dB, typically

## SYNTHESIZED SIGNAL GENERATOR

6060A

## General Specifications

**Temperature:** 0 to 50°C, operating; -40 to 75°C, non-operating**Humidity:** 0 to 95% RH to 30°C; 0 to 75% RH to 50°C, operating**Altitude:** 3,050m (10,000 feet), operating**Shock and Vibration:** Per MIL-T-28800C, except spectral purity may be degraded; 5 to 15 Hz at 0.06 in; 15 to 25 Hz at 0.04 in; and 25 to 55 Hz at 0.02 in**EMI:** Radiated emissions induce  $<3\ \mu\text{V}$  into a 1 inch diameter, 2 turn loop, 1 inch from any surface as measured into a 50 ohm receiver. Also compliance with the following standards:

CE03, MIL STD 461B Power and interconnecting leads, 0.015 to 50 MHz;

RE02, MIL STD 461B 14 kHz to 10 GHz, method RE02-1 and RE02-2 of MIL STD 462;

RS03, MIL STD 461B 14 kHz to 10 GHz, at 1 volt/meter;

FCC Part 15 (j), Class A;

(Designed to meet VDR 0871 Class B)

**Power:** 100V, 120V, 200V, 240V ac  $\pm 10\%$ , 47 to 63 Hz,  $<180\ \text{VA}$ ;  $<15\ \text{VA}$  standby with Option 130**Size:** 50.8 cm L x 43.1 cm W x 13.3 cm H (20 in L x 17 in W x 5¼ in H)**Weight:**  $<15.9\ \text{kg}$  (35 lb)

## Model

January 1985 prices

6060A Signal Generator ..... \$4500

## Options

6060A-130 High Stability Reference ..... 850

6060A-131 Sub-Harmonic Reference ..... 250

6060A-488 IEEE-488 Interface ..... 300

6060A-570 Non-Volatile Memory ..... 400

6060A-651 Low Rate Run ..... 300

6060A-830 Rear Output and Modulation Input ..... 100

6060A-870 Reverse Power Protection ..... 200

## Accessories (Also see page 230)

Y6001 Rack Mount Kit, includes 24" slides ..... 260

Y9100 Attenuator, 50 Ohm, 6 dB, BNC ..... 50

Y9101 Attenuator, 50 Ohm, 14 dB, BNC ..... 50

Y9102 Attenuator, 50 Ohm, 20 dB, BNC ..... 50

Y9103 50 Ohm Feedthru Termination, BNC ..... 30

Y9111 3 ft (0.91m) 50Ω Cable, BNC ..... 15

Y9112 6 ft (1.83m) 50Ω Cable, BNC ..... 15

Y9300 Directional Coupler, BNC ..... 210

Y9301 Min-Loss Pad, 50Ω to 75Ω ..... 260

Y9302 Attenuator, 3 dB, N ..... 85

Y9303 Attenuator, 6 dB, N ..... 90

Y9304 Attenuator, 10 dB, N ..... 90

Y9305 Attenuator, 20 dB, N ..... 90

Y9306 Attenuator, 30 dB, N ..... 90

Y9307 Adapter, N to BNC, 75Ω ..... 15

Y9308 Adapter, N to BNC, 50Ω ..... 15

Y9309 Adapter, N male, N male ..... 15

Y9310 Adapter, N to SMA ..... 40

Y9311 RF Detector, BNC, 100 kHz-12 GHz ..... 135

Y9312 Mixer, BNC, 500 Hz-10 MHz ..... 95

Y9313 Mixer, BNC, 2 MHz-1 GHz ..... 130

Y9314 Power Splitter, 2 MHz-1 GHz, BNC ..... 90

Y9315 Coaxial Cable, N male ..... 60

Y9316 Cap, Non-shorting, BNC ..... 5

Y9317 50Ω Termination, N ..... 90

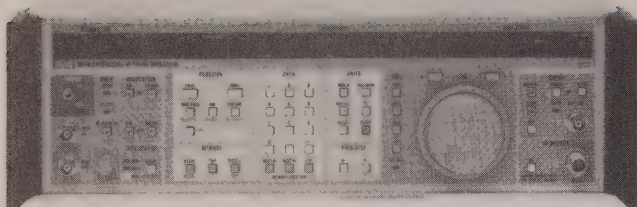
## After-Warranty Service (See page 227)

SC1-6060A, per 90-day interval ..... 756



# SYNTHESIZED SIGNAL GENERATORS

## 6070A/6071A



6070A

### 6070A/6071A, to 520 MHz or 1040 MHz

- Non-harmonic spurious outputs: -90 dBc to -100 dBc to 520 MHz
- Precision digital sweep
- Front panel memory
- AM, FM,  $\phi$ M modulation
- Responsive spin knob tuning
- Low option VSWR and optional reverse-power protection
- Relative amplitude and frequency mode

Design innovations in the 6070A and 6071A combine the precision resolution and settability of a synthesizer with the low-noise performance of the best open-loop signal generators on the market. And these two state-of-the-art instruments were developed to be competitively priced as well as cost effective in other ways.

The 6070A and 6071A are programmable and directly compatible with IEEE Std 488-1978. With them, you may make sophisticated tests and measurements rapidly and with great precision. On VHF and UHF receivers you can measure selectivity, sensitivity, intermodulation distortion, AM rejection, AGC response, audio hum, noise and distortion, and SINAD ratio. Or you can align a discriminator or check IF response using the digital sweep feature.

Spectral purity is excellent. Spurious outputs, those not related harmonically to either the carrier frequency or the power line frequency, are on the order of -90 dBc to -100 dBc to 520 MHz and -84 dBc above 520 MHz. The typical broadband noise floor is a comfortable -150 dBc per Hz, and the single sideband phase-noise is typically -138 dBc per Hz at 20 kHz offset from a 500 MHz carrier. These specifications, by any standard, reflect a truly excellent level of spectral purity.

### AM, FM, $\phi$ M Modulation

Amplitude modulation depth can be set from 0% to 99.9% in 0.1% steps. External dc coupling is provided for leveling, extending bandwidths down to dc, or providing analog control of output amplitude.

Frequency or phase modulation can be set with deviations up to 1 MHz or 100 radians respectively, depending on the rf frequency. Exceptionally wide deviation is made possible by a high deviation mode that is automatically activated when required. External, dc-coupled FM is available for phase locking the instrument to another source. That extends the maximum deviation at low rates, and provides for analog sweeping with an external signal.

Simultaneous AM+FM or AM+ $\phi$ M is available internally or from internal-external combinations. The internal modulation oscillator covers a wide range of frequencies. It can be continually varied from 20 Hz to 200 kHz, with an overrange capability extending it from 1 Hz to 255 kHz in steps of approximately 0.1%.

The modulation oscillator output is available at a front panel connector. This provides you with an audio source separate from the rf output. Typical total harmonic distortion is 0.05%.

### IEEE-488 Interface

No option is required to make the 6070A or 6071A compatible with IEEE Std 488-1978; the capability is built in. And all of the functions that may be controlled from the front panel manually are also controllable remotely in an IEEE-488 system, except for turning power on and off and controlling the modulation signal output level. Status indicators are: Remote, Addressed, and SRQ. Interface functions are: SH1, AH1, T6, L3, SR1, RL1, DC1, DT1, C0, E2.

### Precision Digital Sweep

Versatile sweep modes let you characterize devices such as wideband amplifiers, narrow-band crystal filters, and other rf components. Repetitive, single, or manual modes are available with either symmetrical or asymmetrical sweeps. Five sweep step intervals between 20 ms and 500 ms may be selected. A coincidental 0 to 10V staircase sweep signal is available at an output connector to drive X-Y recorders or oscilloscopes. Another rear-panel output signal provides Z-axis blanking for oscilloscopes or a pen-lift signal for X-Y recorders.

### Front Panel Program Memory

Up to nine different combinations of front-panel control settings may be stored and later recalled. Up to 50 combinations may be stored in a non-volatile memory using Option -570. This feature reduces errors and saves time in making common measurements.

### Responsive Spin-Knob Tuning

In addition to the simple keystroke operation and layout of the front-panel controls, a high-inertia, magnetically detented, optically coupled knob provides analog convenience when continuous adjustments are required. It may be used to select frequency, amplitude, or modulation. Each complete turn gives you 25 increments or decrements, depending on direction of rotation.

### Low Output VSWR and Optional Reverse-Power Protection

The rf output impedance of the 6070A and 6071A is 50 ohms with a low source VSWR to minimize the effects of signals reflected from loads having a high VSWR. Option -870 protects the output circuits from being damaged when connected to a transceiver that accidentally transmits power.

### Relative Units

A relative-amplitude mode makes it easy to compensate for cable loss, attenuation in the rf output, make linearity tests on detectors and amplifiers, and measure AGC characteristics. Output levels are selectable in 0.1 dB steps, all the way from -140 dBm to +19 dBm for frequencies up to 520 MHz (+13 dBm above 520 MHz). Flatness is typically  $\pm 0.2$  dB from 200 kHz to 520 MHz,  $\pm 0.3$  dB to 1040 MHz.

Besides offering 1 Hz resolution up to 520 MHz (2 Hz above 520 MHz), a relative-frequency mode allows you to display specific frequencies above and below a selected center frequency. It makes testing the frequency response of filters and IF strips easy.

### Specifications

Specifications for frequencies above 520 MHz apply to 6071A only.

#### Frequency

6070A Ranges: 0.2 to 519.999 999 MHz

6071A Ranges: 0.2 to 1039.999 998 MHz

6070A Resolution: 1 Hz

6071A Resolution: 1 Hz (<520 MHz), 2 Hz ( $\geq 520$  MHz)

Accuracy & Stability: Same as Reference Oscillator

## SYNTHESIZED SIGNAL GENERATORS

6070A/6071A

## Reference Oscillator

**Internal Standard:** 10 MHz quartz oscillator. Aging rate  $\leq \pm 0.5$  ppm/month. Temperature effects:  $\leq \pm 5$  ppm 0 to 50°C instrument ambient (relative to 25°C)

**Option -130:** 10 MHz ovenized oscillator. (See options)

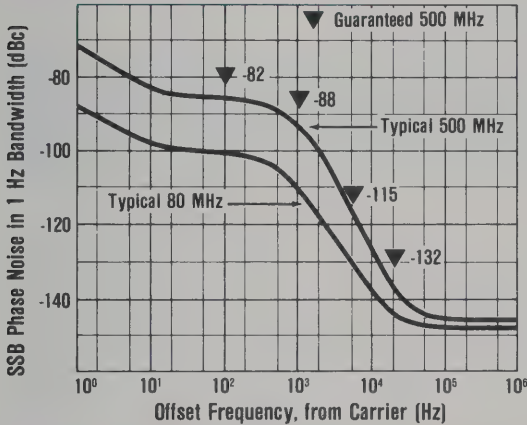
**External:** 1, 2, 2.5, 5, 10 MHz input. Level required is 0.3 to 4.0V pp sinewave or squarewave. Input impedance is 50 ohms. External reference is automatically switched in when connected

**Reference Output:** 10 MHz TTL level

## Spectral Purity

All specifications are with High Deviation mode off

## 6070A &amp; 6071A Phase Noise



## SSB Phase Noise for CW and AM Modes (dBc/Hz)

Carrier Frequency Range	Offset Frequency, from Carrier				
	100 Hz	1 kHz	5 kHz	20 kHz	>3 MHz
0.2 to 62.5 MHz	-75	-85	-106	-123	-129
62.5 to 125 MHz	-94	-100	-125	-140	-144
125 to 250 MHz	-88	-9	-121	-138	-144
250 to 520 MHz	-82	-88	-115	-132	-144
520 to 1040 MHz	-76	-82	-109	-126	-138

## Residual FM for CW and FM Modes (Hz rms)

Carrier Range	0.3 to 3 kHz bw	0.05* to 15 kHz bw
0.2 to 62.5 MHz	3.5	5.0
62.5 to 125 MHz	0.3	0.75
125 to 250 MHz	0.85	1.3
250 to 520 MHz	1.7	2.5
520 to 1040 MHz	3.4	5.0

\*Typically the same for 0.02 to 15 kHz bandwidth.

**Residual AM:**  $\leq 0.02\%$  rms (-74 dBc) in a 0.05 to 15 kHz post-detection bandwidth, referred to 100% sinewave modulation. Typically the same in a 0.02 to 15 kHz post-detection bandwidth

## Spurious Signals (dBc)

Relationship to Output Carrier Frequency ( $f_o$ )	Carrier Frequency Range				
	200 kHz to 62.5 MHz	62.5 MHz to 125 MHz	125 MHz to 250 MHz	250 MHz to 520 MHz	520 MHz to 1040 MHz
Non-Harmonic >10 kHz offset	-90	-100	-96	-90	-84
550 Hz to 10 kHz offset	-70	-82	-76	-70	-64
Power Line, Display, Mechanical <550 Hz offset	-56	-68	-62	-56	-50
Sub-Harmonic $f_o/2$ , $3f_o/2$ , $5f_o/2$ offset	N/A	N/A	N/A	N/A	-35
Harmonic (6070A) $f_o$ , $2f_o$ , $3f_o$ offset, >+13 dBm	-30	-30	-30	-25	N/A
$\leq +13$ dBm	-35	-35	-35	-35	N/A
Harmonic (6071A) $f_o$ , $2f_o$ , $3f_o$ offset, >+13 dBm	-30	-30	-25	-20	N/A
$\leq +13$ dBm	-35	-35	-35	-35	-25

## Output

**Voltage Level Range:** -140 dBm to +19 dBm for frequencies up to 520 MHz. Above 520 MHz (6071A), -140 dBm to +13 dBm

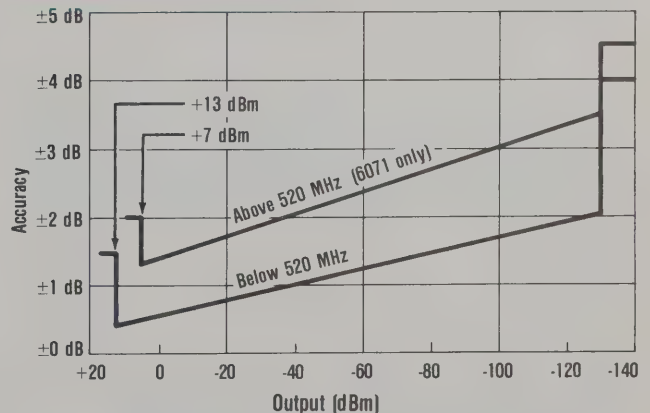
**Resolution:** 0.1 dB or 1% of voltage

## Accuracy (dB)

Output	Without Opt -870		With Opt -870		
	0.2 to 520 MHz	520 to 1040 MHz	0.2 to 520 MHz	520 to 1040 MHz	
+19 to +13 dBm	±1.5	N/A	±2.0	N/A	
+13 to +7 dBm	±(0.8 - 0.01L)*	±2.5	±(1.3 - 0.01L)*	±3.0	
+7 to -131 dBm		±(1.6 - 0.015L)*		±(2.2 - 0.015L)*	
-131 to -140 dBm					
	±4	±4.5	±4.5	±5	

\*L = Level in dBm

## Output Level Accuracy vs Level



**Output Impedance:** 50 ohms, nominal

## SWR

Output Level	0.2 to 520 MHz	520 to 1040 MHz
$\geq +7$ dBm	2.0	2.5
<+7 dBm	1.5	2.0



# SYNTHESIZED SIGNAL GENERATORS

**6070A/6071A**

## Amplitude Modulation

**AM Depth:** 0 to 99.9% in 0.1% steps

**AM Accuracy:** (Internal or External)

Carrier Range	Modulation Frequency	AM Depth	Depth Accuracy
0.2 to 5 MHz	≤1 kHz	<90%	+5%, -8%
5 to 520 MHz	≤3 kHz	<90%	±5%
520 to 1040 MHz	≤3 kHz	≤70%	±5%

## AM Distortion

Carrier Range	Modulation Frequency	AM Depth		
		0 to 30%	30 to 70%	70 to 90%
0.2 to 5 MHz	≤1 kHz	<2%	<5%	<7%
5 to 520 MHz	≤3 kHz	<1.5%	<3%	<3%
520 to 1040 MHz	≤3 kHz	<3%	<3%	<5%

## AM Signal Bandwidth (-3 dB)

Current Range	AM Depth	Internal or External AC Coupled	External DC Coupled
0.2 to 5 MHz	≤70%	20 Hz to 8 kHz	DC to 8 kHz
5 to 520 MHz	≤90%	20 Hz to 50 kHz	DC to 50 kHz
520 to 1040 MHz	≤70%	20 Hz to 50 kHz	DC to 50 kHz

**Incidental FM (for 30% AM):** 0.3 x modulation frequency for <520 MHz; 0.6 x modulation frequency for >520 MHz

## Frequency Modulation

**Maximum Peak Frequency Deviation (kHz)**

Frequency Range	ACFM, the lesser of	DCFM, the lesser of
0.2 to 62.5 MHz	999 or $f_m \times (520 - f_o)$	499
62.5 to 125 MHz	199 or $f_m \times f_o$	$f_o$ or 99.9
125 to 250 MHz	499 or $f_m \times f_o$	$f_o$ or 199
250 to 520 MHz	999 or $f_m \times f_o$	$f_o$ or 499
520 to 1040 MHz	999 or $f_m \times f_o$	$f_o$ or 999

 $f_o$  = Output frequency in megahertz

 $f_m$  = Modulation frequency in kilohertz

**FM Deviation Resolution:** 100 Hz for <100 kHz deviation; 1 kHz for ≥100 kHz deviation

**FM Deviation Accuracy:** (Internal or external) ±10% at 400 Hz or 1 kHz modulation rate; ±13% at 0.3 to 50 kHz modulation rate (including flatness)

## FM Total Harmonic Distortion

Output Frequency Range	DCFM Mode Off and High Deviation:	On	DCFM Mode On
	Off		
	0.5%+		0.5%+
0.2 to 62.5 MHz	0.75% per 100 kHz dev	1.5%	1.2% per 100 kHz dev
62.5 to 125 MHz	3.0% per 100 kHz dev		(600 ± $f_o$ ) % per 100 kHz dev
125 to 250 MHz	1.5% per 100 kHz dev		
250 to 520 MHz	0.75% per 100 kHz dev		
520 to 1040 MHz	0.375% per 100 kHz dev		

 $f_o$  = Output frequency in megahertz

**FM Signal Bandwidth (-3 dB):** 20 Hz to 250 kHz internal or ac coupled external. Dc to 250 kHz dc coupled external  
**Center Frequency Accuracy (DCFM Off):** Same as reference oscillator

## Center Frequency Accuracy (DCFM On)\*

Output Frequency Range	Initial Accuracy	Typical Stability
0.2 to 62.5 MHz	±1 kHz	50 Hz/min
62.5 to 125 MHz	±250 Hz	12.5 Hz/min
125 to 250 MHz	±500 Hz	25 Hz/min
250 to 520 MHz	±1 kHz	50 Hz/min
520 to 1040 MHz	±2 kHz	100 Hz/min

\*Auto-CAL upon initialization

**Incidental AM:** ≤0.5% (-52 dBc) for deviations up to 50 kHz at 1 kHz rate (single sideband) component referred to sinewave modulation

## Phase Modulation Deviation and Distortion

Output Frequency Range	Max Peak Deviation Radians	Total Harmonic Distortion per Radian of Deviation with High Deviation Mode	
		Off	On
0.2 to 62.5 MHz	99.9	0.5 + (0.75 × 10 <sup>5</sup> × $f_m$ ) %	1.5%
62.5 to 125 MHz	19.9	0.5 + (3.0 × 10 <sup>5</sup> × $f_m$ ) %	
125 to 250 MHz	49.9	0.5 + (1.5 × 10 <sup>5</sup> × $f_m$ ) %	
250 to 520 MHz	99.9	0.5 + (0.75 × 10 <sup>5</sup> × $f_m$ ) %	
520 to 1040 MHz	99.9	0.5 + (0.375 × 10 <sup>5</sup> × $f_m$ ) %	

 $f_m$  = Modulation frequency in hertz

**φM Resolution:** 0.01 radian for <10 radians, 0.1 radian for ≥10 radians

**φM Deviation Accuracy:** (Internal or external) ±10% at 400 Hz or 1 kHz modulation rate; ±13% at 0.3 to 3 kHz modulation rate (including flatness)

**φM Signal Bandwidth (-3 dB):** 0.02 to 12 kHz internal or ac coupled external. Dc to 12 kHz external dc coupled

**Incidental AM:** ≤0.5% (-52 dBc) for deviations up to 50 radians at a 1 kHz rate (single sideband component referred to sinewave modulation)

## Modulation Signal Source

**Modes:** AM, FM, φM, AM + FM, AM + φM

**Range:** 0.02 kHz to 200 kHz

**Frequency Accuracy:** ±3% for 20°C to 30°C ambient temperature range.

Add 0.1% per degree C outside that range

**Total Harmonic Distortion:** <0.15% from 0.2 kHz to 100 kHz; <0.2% below 0.2 kHz and above 100 kHz

**Output Level:** 0V to 20V peak to peak into 600Ω

**Output Impedance:** 600Ω, nominal via front panel BNC connector

## External Modulation Input

**Level:** 1V peak for specified AM, FM, or φM accuracy

**Impedance:** 600Ω, nominal

**Coupling:** AC or DC

## Switching Time

**Frequency:** <85 ms from last controller command (<35 ms for most small changes) until frequency has settled to within 100 Hz of final value. Applies to frequency changes only

**Level:** <50 ms from last controller command. Applies to level changes only

## Frequency Sweep

**Sweep Modes:** Auto, Single, Manual

**Sweep Functions:** Symmetrical sweep, asymmetrical sweep, sweep speed

**Data Entry:** Sweep width, sweep increment

**Sweep Speed:** Approximately 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, per increment

**Sweep Output:** 0 to +10V, up to 1000-point stepped ramp. Available at front panel BNC connector

**Penlift/Z Axis Blanking:** TTL output level at rear panel BNC connector. High during sweep retrace and when sweep is off

## SYNTHESIZED SIGNAL GENERATORS

6070A/6071A

**Memory**

**Memory Functions:** Store, recall, insert above, delete, top  
**Locations:** 9 standard, volatile; Option-570 50 non-volatile. Front panel set-ups can be stored in each location and later re-called

**Remote Programming**

**Interface:** IEEE-488

**Functions Controlled:** All front-panel controls except line power switch and modulation output amplitude (MOD OUT)

**Status Indicators:** Remote, Addressed, SRQ.

**Interface Functions:** SH1, AH1, T6, L3, SR1, RL1, DC1, DT1, C0, E2

**Option Specifications****10 MHz Ovenized Oscillator (-130)**

Aging rate  $\leq \pm 5 \times 10^{-10}$  per day after a 21-day warmup. Temperature effects:  $\leq \pm 2 \times 10^{-10}/^{\circ}\text{C}$

**Non-Volatile Memory (-570)**

50 locations; operational features same as standard features. Data is stored with built in battery when power is off

**Rear RF Output (-830)**

Type N rf output connector available on rear panel

**Auxiliary RF Output (-831)**

Greater than -18 dBm, available at rear panel BNC. Impedance, 50 ohms

**Reverse Power Protection (-870)**

Up to 50 watts from a 50 ohm source over 0.2 to 1040 MHz. Will withstand up to 50V dc

**General Specifications**

**EMI:** Meets MIL-STD 461A RE03 and CE03, and MIL-I-6181D Sections 4.3.1 and 4.3.2 for both narrowband and broadband tests. RF leakage: less than  $3 \mu\text{V}$  is induced into a two-turn, 1 inch diameter loop 1 inch away from any surface and measured into a 50 $\Omega$  receiver

**Temperature:** 0 $^{\circ}\text{C}$  to 50 $^{\circ}\text{C}$ , operating; -40 $^{\circ}\text{C}$  to +75 $^{\circ}\text{C}$ , non-operating

**Relative Humidity:**  $\leq 95\%$  to 25 $^{\circ}\text{C}$ ;  $\leq 75\%$  to 50 $^{\circ}\text{C}$

**Altitude:**  $\leq 10,000$  feet

**Power:** 100, 120, 200, 240V ac  $\pm 10\%$  47 to 63 Hz; 125 watts typical. For 400 Hz operation consult your Fluke representative

**Size:** 13.3 cm H x 43.2 cm W x 54.6 cm D from front panel to rear handle (5.25 in H x 17.0 in W x 21.5 in D)

**Weight:** 27.7 kg (61 lb)

**Included:** Operator's manual, service manual, power cord

**Models**

January 1985 prices

6070A Synthesized Sig Gen (0.2-520 MHz)	\$17,100
6071A Synthesized Sig Gen (0.2-1040 MHz)	18,100

**Options**

607XA-130 Ovenized Reference Oscillator	1100
607XA-570 Non-Volatile Memory	550
607XA-830 Rear RF Output	120
607XA-831 Auxiliary RF Output	170
607XA-870 Reverse Power Protection	250

**Accessories (Also see page 230)**

Y6001 Rack Mount Kit, includes 24" slides	260
Y9100 Attenuator, 50 Ohm, 6 dB, BNC	50
Y9101 Attenuator, 50 Ohm, 14 dB, BNC	50
Y9102 Attenuator, 50 Ohm, 20 dB, BNC	50
Y9103 50 Ohm Feedthru Termination, BNC	30
Y9111 3 ft (0.91m) 50 $\Omega$ Cable, BNC	15
Y9112 6 ft (1.83m) 50 $\Omega$ Cable, BNC	15
Y9300 Directional Coupler, BNC	210
Y9301 Min-Loss Pad, 50 $\Omega$ to 75 $\Omega$	260
Y9302 Attenuator, 3 dB, N	85
Y9303 Attenuator, 6 dB, N	90
Y9304 Attenuator, 10 dB, N	90
Y9305 Attenuator, 20 dB, N	90
Y9306 Attenuator, 30 dB, N	90
Y9307 Adapter, N to BNC, 75 $\Omega$	15
Y9308 Adapter, N to BNC, 50 $\Omega$	15
Y9309 Adapter, N male, N male	15
Y9310 Adapter, N to SMA	40
Y9311 RF Detector, BNC, 100 kHz-12 GHz	135
Y9312 Mixer, BNC, 500 Hz-10 MHz	95
Y9313 Mixer, BNC, 2 MHz-1 GHz	130
Y9314 Power Splitter, 2 MHz-1 GHz, BNC	90
Y9315 Coaxial Cable, N male	60
Y9316 Cap, Non-shorting, BNC	5
Y9317 50 $\Omega$ Termination, N	90

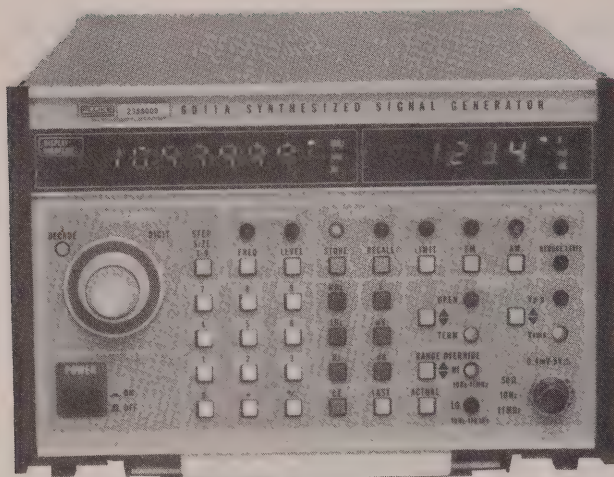
**After-Warranty Service (See page 227)**

SC1-6070A, per 90-day interval	756
SC1-6071A, per 90-day interval	888



# SYNTHESIZED SIGNAL GENERATOR

6011A



6011A

## 6011A Synthesizer

- 0.1 Hz (7-digit) resolution to 110 kHz; 10 Hz resolution to 11 MHz
- Storage of up to 9 different frequencies
- Residual noise -50 dBc
- Harmonics -35 to -50 dBc
- Level flatness = 0.5 dB
- Frequency switching 2 ms

The 6011A has an output impedance of 50 ohms (75 ohms optional) over the entire frequency range of 10 Hz to 11 MHz, selectable with 0.1 Hz (7-digit) resolution to 110 kHz, 10 Hz resolution to 11 MHz. Frequency is displayed using a 7-digit LED readout. The rms output voltage into a 50 ohm load ranges from 400  $\mu$ V to 5V or 10V rms into an open circuit or high impedance load. Referred to 1 milliwatt in a 50 ohm load, ranges from -55 dBm to +27 dBm.

The output may be in units of dBm, volts, or millivolts selected with 4-digit resolution using calculator-like front panel pushbuttons and displayed on LEDs. And the output level may be selected in terms of peak-to-peak voltage as well as rms voltage.

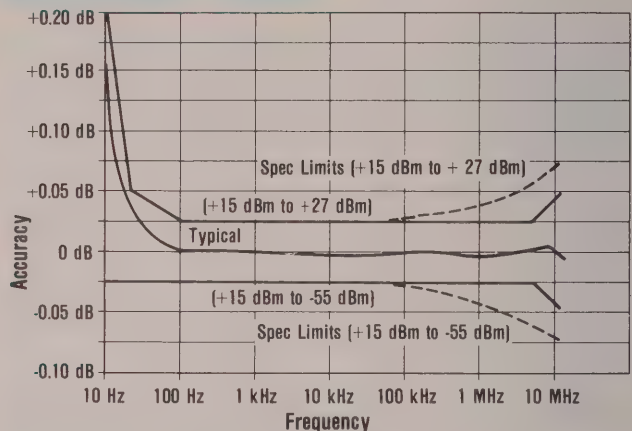
To avoid accidentally selecting an excessive output voltage, a limit may be stored in the 6011A. In addition, you may store up to nine different frequencies and/or output levels that may be recalled at random, quickly and without error — an important consideration for repetitive testing.

Selecting seven-digit frequency resolution is automatic — you don't need to select the high or low range or all seven digits when ending digits are zero. However, you may deliberately override the automatically-selected range when desirable.

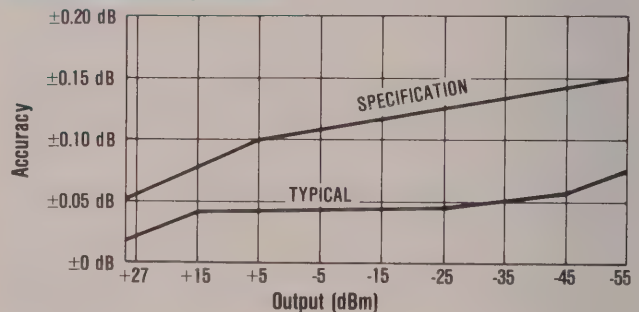
Any selected frequency may be increased or decreased in steps of practically any size, using the EDIT controls. This provides a manual sweep capability for checking frequency response, peaks, nulls, etc. A frequency or output level may be stored as a reference with other frequencies or levels added or subtracted within the instrument's range. This is useful for making relative measurements.

The 6011A can be controlled remotely and operate as part of a system. Option -05 makes the instruments compatible with IEEE Std 488 and Option -06 gives them compatibility with EIA Standard RS-232-C. A seven-line ASCII bit-parallel interface is standard, when you don't order option -05 or -06. All front-panel functions are controllable remotely except for line power and open-terminated-load selection. The IEEE-488 Interface Option has the repertoire AH1, L2, RL1, and E1.

## Output Level Accuracy vs Frequency



## Output Level Accuracy vs Level



## SYNTHESIZED SIGNAL GENERATOR

6011A

## Specifications

PARAMETER	
<b>Frequency</b>	
Low Range	10 Hz to 109.9999 kHz
High Range	10 Hz to 10.99999 MHz
Range Selection	Automatic, with manual override
Resolution	0.1 Hz in the low range 10 Hz in the high range
Display	Seven-digit LED display of frequency set by local or remote control
Annunciation	Units automatically justified in the LED display to indicate maximum resolution
Accuracy	$\pm 3$ parts in $10^6$ for one year over the temperature range of 0°C to +50°C
Aging Rate	<1 part in $10^6$ per day of 1 part in $10^6$ per year at constant temperature
Temperature	$\leq \pm 2$ parts in $10^6$ from 0°C to +50°C ( $\leq \pm 5$ parts in $10^7$ from 0°C to +50°C with Option -01)
External Reference	Requires a 10 MHz TTL compatible square wave with symmetry between 40% and 60%. Internal reference is automatically selected in the absence of an external reference
Local Control	Keyboard selection of numerical data, magnitude (Hz, kHz, MHz) and functions. Edit control provided for modifying entry. 6011A programmable in steps of 1-9.
Frequency Storage	Facility to store and recall 9 front-panel control settings including frequency, level, modulation, and output terminal parameters
Remote Control	ASCII standard. IEEE-488 or RS-232-C Optional
Switching and Settling Time	Frequency settles to within 10 Hz of final frequency in low range and 1 kHz in high range in <2 ms in fixed form <34 ms in free form (excluding recall)
<b>Spectral Purity</b>	
Harmonic, Spurious	-30 dBc from 10 Hz to 100 Hz -50 dBc from 100 Hz to 1 MHz -40 dBc from 1 MHz to 11 MHz (Except -35 dBc for output levels within 2 dB of max output from 5 MHz to 11 MHz). Total harmonic distortion from 100 Hz to 110 kHz is <0.15% (typically 0.07%) on low range and 0.3% (typically 0.1%) on high range
Non-Harmonic, Spurious	All non harmonically-related outputs <-60 dBc or -110 dBm whichever is greater
Phase Noise	-46 dBc as measured in a 30 kHz bandwidth excluding 1 Hz centered on the carrier, including the effects of the internal standard. Residual (excluding internal standard) is <-50 dBc. Approximately 8 dB improvement on low range
Phase Noise Spectral Density (Typical)	SSB Phase Noise at the output measured in a 1 Hz bandwidth at max output. Approx. 10 dB improvement on low range
Offset from Carrier	SSB Phase Noise
20 Hz	-102 dBc
200 Hz	-108 dBc
20 kHz	-106 dBc
1 MHz	-130 dBc

PARAMETER	
<b>Amplitude</b>	
Impedance	50 $\Omega$ (75 $\Omega$ w/Option -10)
Range:	
dBm	+26.98 dBm to -55.01 dBm into 50 $\Omega$
Volts	5.000V rms to 0.3972 mV rms into 50 $\Omega$
Local Control	Keyboard selection of output level in V, mV or dBm. Voltage is selectable in terms of V rms or V p-p and terminated or open circuit. Rotary knob provided for modifying entry and is programmable in steps of 1 through 9
Resolution	0.25V/div
Accuracy	See Graph
Frequency Response	See Graph
Stability vs. Temp	Typical temperature coefficient is 0.003 dB/°C, 20°C to 30°C $\pm 0.2$ dB, 0°C to 50°C
Switching and Settling Time	To within: $\pm 1$ dB, 150 ms fixed form, $\pm 0.1$ dB, 300 ms fixed form, $\pm 0.01$ dB, 450 ms fixed form. (Add 200 ms for free form.)
Display	dB; 4-digit LED plus sign in dBm or dB with respect to a stored dBm reference. Volts: 4-digit in V p-p or V rms; open circuit or terminated or volts or dB with respect to a stored voltage reference
AM Modulation	Analog input can be used to provide amplitude modulation. Bandwidth of this input is 10 kHz and max modulation is 90%. Z in = 600 $\Omega$ 9V p-p corresponds to 90% modulation
Remote Control	ASCII standard. IEEE-488 or RS-232-C Optional
<b>Remote Interfaces</b>	
Standard	Byte serial, bit parallel, seven ASCII-defined parallel lines, plus two handshake lines. Mating Connector Amphenol 57-30240. Also Option -05 and -06
<b>Outputs</b>	
TTL Output	TTL-compatible square wave output (<0.5V to >2.4V p-p into 50 $\Omega$ ) at the synthesized output frequency
Reference Outputs	Derived from the synthesizer frequency reference. 1 MHz output is standard; 5 or 10 MHz available by changing internal jumper. Output is TTL-compatible square wave
Rear Panel Output	Option -04
20 to 31 MHz Tracking	Option -09
75 $\Omega$	Option -01



# SYNTHESIZED SIGNAL GENERATOR

**6011A**

## Option Specifications

### High Performance TCXO Option (-01)

**Frequency Accuracy:**  $\pm 1.5$  parts in  $10^6$  for one year over the temperature range of  $0^\circ\text{C}$  to  $+50^\circ\text{C}$

**Aging Rate:**  $< 1$  part in  $10^8$  per 24 hours at constant temperature, or 1 part in  $10^6$  per year

**Temperature Dependence:**  $< \pm 5$  parts in  $10^7$  from  $0^\circ\text{C}$  to  $+50^\circ\text{C}$

### Phase-Lockable Input Option (-02)

**Input Frequency:** 1, 2, 2.5, 5 or 10 MHz

**Input Level:**  $> 100$  mV,  $< 5$  V rms into  $50\Omega$ . May be used with either the standard oscillator or Option -01. Locking range is  $\pm 5$  parts in  $10^6$  from frequency of internal oscillator

### Frequency Modulation Option (-03)

General	High Range	Low Range
Deviation	$\pm 20$ kHz	$\pm 200$ Hz
Input	1V for 4 kHz $\pm 5$ V max	1V for 40 Hz $\pm 5$ V max
Accuracy	$\pm 1.5$ kHz	$\pm 15$ Hz
Rate	dc to 10 kHz	dc to 10 kHz
Linearity at Constant Temp	$\pm 1$ kHz	$\pm 10$ Hz
Stability at Constant Temp	$\pm 400$ Hz	$\pm 4$ Hz
Incidental AM, Typical	$< 1\%$	$< 0.5\%$
Impedance	$600\Omega$	$600\Omega$

### IEEE-488 Interface Option (-05)

Compatible with IEEE Std 488-1978 for use in instrumentation systems. Interface functions are AH1, L2, RL1, and E1.

### RS-232-C Interface Option (-06)

Bit serial interface compatible with EIA Standard RS-232-C. Asynchronous data rates from 110 to 9600 baud. Either voltage-level interface or 20 mA current loop. 32-character FIFO buffer.

## General Specifications

**Altitude:** To 3048 meters (10,000 feet) operating

**Temperature:**  $0^\circ\text{C}$  to  $50^\circ\text{C}$ , operating;  $-40^\circ\text{C}$  to  $75^\circ\text{C}$ , non-operating

**Relative Humidity:**  $\leq 80\%$  to  $50^\circ\text{C}$

**Power:** 115V or 230V ac  $\pm 10\%$ , 50 to 60 Hz, 100W, standard. Also 50 to 400 Hz optional and 100V ac optional

**Size:** 13.3 cm H x 21.6 cm W x 48.2 cm D (5.25 in x 8.5 in x 19 in)

**Weight:** 11.4 kg (25 lb)

**Included:** Manual and power cord

## Model

January 1985 prices

6011A Synthesized Signal Generator ..... \$5665

## Options

6011A-01 High Performance TCXO .....	340
6011A-02 <sup>1</sup> Phase Lock Input .....	340
6011A-03 <sup>1</sup> Frequency Modulation .....	910
6011A-04 Rear Panel Output .....	30
6011A-05 <sup>2</sup> IEEE-488 Interface .....	345
6011A-06 <sup>2</sup> EIA Standard RS-232-C Interface .....	635
6011A-07 50-400 Hz Line Power .....	375
6011A-08 100V, 50-60 Hz Line Power .....	275
6011A-09* 20-31 MHz Tracking Output .....	55
6011A-10 75 $\Omega$ Output Impedance .....	140

\* Field installable options — order -03K, -05K, or -09K

<sup>1</sup> Cannot have -02 and -03 options together

<sup>2</sup> Cannot have -05 and -06 options together

## Accessories (Also see page 230)

Y9111 3 ft (0.93m) 50 $\Omega$ BNC Cable .....	15
Y9112 6 ft (1.85m) 50 $\Omega$ BNC Cable .....	15
M05-203-601 5/4" Rack Adapter, Offset .....	110
M05-203-602 5/4" Rack Adapter, Centered .....	110
M05-200-603 5/4" Rack Adapter, Dual .....	110
M00-203-631 5/4" Rack Adapter w/18" slides .....	160

## After-Warranty Service (See page 227)

SC1-6011A, per 90-day interval ..... 464

**FOR LEASE**

See page 238

# FREQUENCY SYNTHESIZERS

**6160B & 6039A/AZ**

**6160B**

## 6160B & 6039A/AZ Frequency Synthesizers

- High spectral purity: residual phase noise typically less than -74 dB
- Resolution: 0.1 Hz below 4 MHz; 1 Hz above (6039A/AZ) 0.1 Hz below 12 MHz; 1 Hz above (6160B)
- Level flatness:  $\pm 1$  dB into 50 ohms
- Switching speed: 800  $\mu$ s
- Built-in BCD programming (6160B only)
- Optional IEEE-488 (6160B only)

### 6160B Frequency Synthesizer

The Fluke 6160B Frequency Synthesizer is the industry's most popular VHF synthesizer because of its high spectral purity. It produces frequencies from 1 MHz to 160 MHz in two ranges: 1 MHz to 12 MHz and 10 MHz to 160 MHz. Frequency resolution is 0.1 Hz on the 12 MHz range and 1.0 Hz on the 160 MHz range.

A unique feature of the 6160B is that the highest internally-generated frequency is that of the output VCO, i.e., 80 to 160 MHz. This makes servicing easier, and eliminates UHF EMC problems. Since the output VCO in the 6160B operates from 80 to 160 MHz, frequency division is employed for coverage of lower frequencies. This results in improved spurious specifications for frequencies lower than 80 MHz. Phase noise is similarly reduced for lower bands.

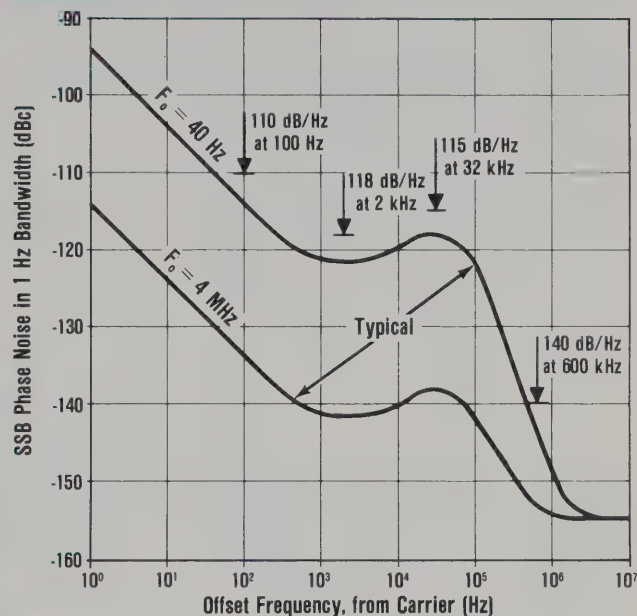
Built-in remote programming is DTL/TTL, BCD, positive true logic or by contact closures. Programming of frequency is via 34 parallel lines, and a remote flag and power flag are provided. Switching is fast, output level is electrically adjustable. Compatibility with IEEE Std 488-1978 is achieved using the Fluke 1120A Translator and 6XXA-529 Interface.

### 6039A/AZ Frequency Synthesizer

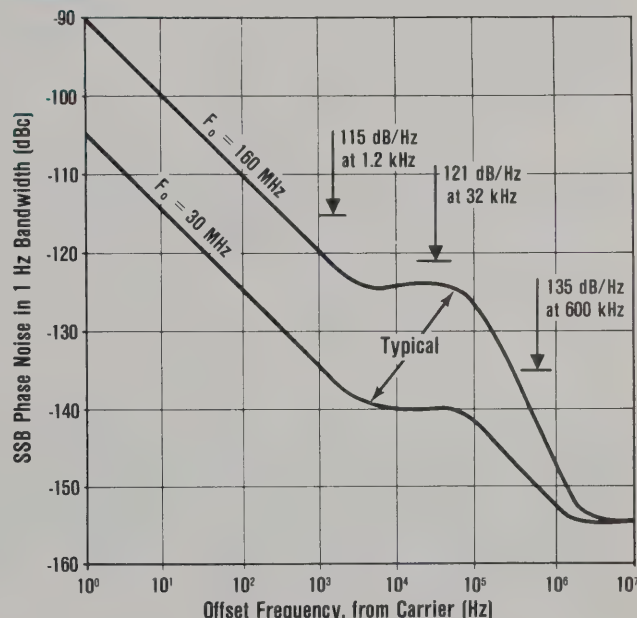
The Model 6039A/AZ is very similar to Model 6160B except it has an upper frequency limit of 40 MHz instead of 160 MHz. The lower range is 1 to 4 MHz and the higher range is 4 to 40 MHz. Frequency resolution is 0.1 Hz on the lower range and 1.0 Hz on the higher range. The main RF output (rear) has a fixed level of +21 dBm into 50 ohms. Auxiliary output of 1 MHz and 100 kHz are also provided.

The highest internally-generated frequency is that of the output VCO, 20 to 40 MHz. This makes servicing easier, eliminates EMC problems at VHF frequencies, and improves phase noise and spurious specifications for frequencies below 20 MHz. The low noise floor of -155 dB/Hz makes this unit ideal for communication systems. The 6039A/AZ does not have remote control capabilities.

### 6039A/AZ



### 6160B





# FREQUENCY SYNTHESIZERS

## 6160B & 6039A/AZ

### Specifications

PARAMETER	6160B	6039A/AZ
<b>Frequency</b>		
High Band Range	10 MHz to 160 MHz	2.5 MHz to 40 MHz
Minimum Step	1 Hz	1 Hz
Low Band Range	1 MHz to 12 MHz	1 MHz to 4 MHz
Minimum Step	0.1 Hz	0.1 Hz
Local Control	Front panel rotary switches	
Remote Control	BCD per decade, TTL, DTL positive true logic or contact closures. Logic "0" = 0 to 0.9V dc. Logic "1" = 2V to +5V dc or open circuit.	Not available for 6039A/AZ
Spectral Purity*		
	Non-Harmonic, Spurious	
	MHz      dBc	MHz      dBc
	1 to 20      -100	1 to 4      -100
	20 to 40      -95	4 to 5      -98
	40 to 80      -89	5 to 10      -92
	80 to 160      -83	10 to 20      -86
		20 to 40      -80
Harmonic, Spurious	<-25 dBc, typically <-30 dBc	
Amplitude Noise**	<-94 dBc (typical)	<-94 dBc (typical)
Absolute Phase Noise** (Including effects of int'l standard)	<-62 dBc (typical)	<-70 dBc (typical)
Residual Phase Noise** (Not including effects of int'l standard)	<-74 dBc (typical)	<-74 dBc (typical)
Phase Noise Spectral Density 1 Hz Bandwidth	Offset from Carrier	Offset from Carrier
	SSB Phase Noise	SSB Phase Noise
	1.2 kHz      <-115 dBc	100 Hz      <-110 dBc
	32 kHz      <-121 dBc	2 kHz      <-118 dBc
	600 kHz      <-135 dBc	32 kHz      <-115 dBc
		600 kHz      <-140 dBc
<b>Outputs</b>		
Main Output	Adjustable from +3 dBm to +13 dBm into 50 $\Omega$ (0.3V to 1V rms) with front-panel control or external dc voltage. Level maintained +1 dB into 50 $\Omega$	
Other Outputs	5 MHz at nominally 1V rms into 50 $\Omega$	5 MHz at nominally 1V rms into 50 $\Omega$
Output Options	Rear Panel, Opt -04	Rear Panel, Opt -04 +21 dBm Output, Opt -09 10 MHz, Opt -06 1 MHz, Opt -07 100 kHz, Opt -08 Note: Options -06, -07, and -08 are mutually exclusive and replace the standard 5 MHz output
<b>Miscellaneous</b>		
Reference Frequency	External, 5 MHz at 0 dBm to +16 dBm into 50 $\Omega$	
Level Control	External, 0.1 to 0.8V dc nominal into >2 k $\Omega$ produces an output level change of from +3 dBm to +13 dBm	
Switching Speed	<800 $\mu$ s to be within 50 Hz of final frequency (applies for frequencies from 80 MHz to 160 MHz. Improves at lower freq.)	<800 $\mu$ s to be within 100 Hz of final frequency (applies for frequencies from 20 MHz to 40 MHz. Improves at lower freq.)
Internal 5 MHz Frequency Option -02, -05, or Other Source	Option      Aging Rate -02 $\pm 2 \times 10^{-5}$ /day -05 $\pm 5 \times 10^{-5}$ /yr	Temp. Stability 1 x 10 $^{-8}$ , 0°C to 50°C 1 x 10 $^{-8}$ , 0°C to 40°C

\* Noise specifications are for frequencies from 80 MHz to 160 MHz for the 6160B and 20 MHz to 40 MHz for the 6039A/AZ. Noise performance improves for lower frequencies.

\*\* Measured in a 30 kHz band excluding the 1 Hz band centered on the signal frequency.

### General Specifications

Altitude: To 3048 meters (10,000 feet), operating; 15240 meters (50,000 feet), non-operating

Temperature: 0°C to 50°C, operating; -62°C to +70°C, non-operating

Relative Humidity:  $\leq 80\%$  to 50°C

Power: 115V or 230V ac  $\pm 10\%$ , switch-selectable, 50 to 440 Hz. 80W for 6160B. 55W to 81W for 6039A, depending on options.

6039A/AZ Size: 48.3 cm W x 13.3 cm H x 50.8 cm L (19 in x 5.25 in x 20 in)

6160B Size: 48.3 cm W x 17.8 cm H x 50.8 cm L (19 in x 7 in x 20 in)

6039A/AZ Weight: 19 kg (42 lb)

6160B Weight: 20.5 kg (45 lb)

Included: Manual, power cord, mating connector for programming input lines

### Models

January 1985 prices

6160B\* Frequency Synthesizer ..... \$8315

6039A/AZ\* Frequency Synthesizer ..... 8990

\*Option -02, -05 or an external 5 MHz time base is required

### Options

6039/6160B-02\* Frequency Std. 2x10 $^{-9}$ /day ..... 935

6039/6160B-04 Rear Panel RF Output ..... 50

6039/6160B-05\* Frequency Std. 5x10 $^{-6}$ /year ..... 365

6XXA-522K 1120A Interface, field installable ..... 310

6XXA-529\*\* IEEE-488 Interface ..... 365

\* Factory or Service Center installation only.

\*\* Requires 1120A IEEE-488 Translator. Includes 6XXA-522K and Y7205 Cable.

### Options for 6039A/AZ

6039A-06\* 10 MHz Buffered Output ..... 30

6039A-07\* 1 MHz Buffered Output ..... 295

6039A-08\* 100 kHz Buffered Output ..... 295

6039A-09 +21 dB Output Amplifier ..... 450

\* Instead of standard 5 MHz Auxiliary Output. Factory or Service Center installation only.

### Accessories (Also see page 230)

1120A IEEE-488 Translator ..... 520

Y7205 6 ft Ribbon Cable for 6XXA-522K ..... 70

Y9111 3 ft (0.93m) 50 $\Omega$  BNC Cable ..... 15

Y9112 6 ft (1.85m) 50 $\Omega$  BNC Cable ..... 15

M07-205-600 7" Rack Adapter ..... 100

M00-280-610 24" Rack Slides (Rack Adapter req'd) ..... 110

### After-Warranty Service (See page 227)

SC1-6160B, per 90-day interval ..... 520

SC1-6039A/AZ, per 90-day interval ..... 528

## What is Calibration?

Calibration is a special, highly-refined measurement process in which one compares test and measurement instruments of unknown status to well-defined standards of greater accuracy in order to detect, eliminate by adjustment, and report any variations in accuracy or capability. In other words, it is a process verifying the operational integrity of instruments. It provides two major benefits. First, it allows you to use your instruments with confidence by minimizing the uncertainties associated with them. Second, it fulfills the requirements to "traceability" to national standards demanded so frequently today.

## Calibrators

Model	Direct Voltage (dV)	Alternating Voltage (aV)	Direct Current (dI)	Alternating Current (aI)	Resistance	Wideband	Basic Uncertainty	IEEE-488	Page
335A	To 1110V	—	—	—	—	—	20 ppm	No	106
335D	To 1110V	—	—	—	—	—	10 ppm	No	106
343A	To 1100V	—	—	—	—	—	20 ppm	No	107
515A	To 100V	To 100V	—	—	10 $\Omega$ to 100 M $\Omega$	—	30 ppm	No	105
3330B	To 1111V	—	To 100 mA	—	—	—	15 ppm	No	108
5100B	To 1100V	To 1100V	To 2A	To 2A	1 $\Omega$ to 10 M $\Omega$	Option	50 ppm	Option	97
5101B	To 1100V	To 1100V	To 2A	To 2A	1 $\Omega$ to 10 M $\Omega$	Option	50 ppm	Option	97
5200A	—	To 120V	—	—	—	—	200 ppm	Option	101
5440B	To 1100V	—	—	—	—	—	3 ppm	Yes	94
5442A	To 1100V	—	—	—	—	—	4 ppm	Yes	94
5450A	—	—	—	—	1.0 $\Omega$ to 100 M $\Omega$	—	8 ppm	Yes	104
7105A	To 1100V	—	—	—	—	Resistance Ratio	4 ppm	No	109

## Amplifiers

Model	Output Range	Compatible Calibrators	Gain/ Transcond.	AC-Coupled	DC-Coupled	Page
5205A	1200V rms 1600V dV	5100B 5101B 5102B 5200A 5440B	100	Yes	Yes	112
5215A	1200V rms	5200A	100	Yes	No	114
5220A	To 20A	5100B 5101B 5102B 5440B	1A/V	—	Yes	116

## Reference Standards

Model	Stability (Amplitude)	aV	dV	Frequencies	DVMp*	Page
510A	$\pm 0.005$ % in 30 Days	—	10V rms	50 Hz to 100 kHz	No	126
731B	10 ppm	10V 1V 1.018V $\Delta$ V	—	—	No	122
732A	0.5 ppm	10V 1V 1.018V	—	—	Yes	120

\*Direct Voltage Maintenance Program

## Computer-Aided Calibration

Model	Oscilloscope Calibration	Multimeter Calibration	Benchtop Cluster	Measurement Capability	Page
7404B	—	Yes	Yes	Yes	135
7405A	—	Yes	—	Yes	138
7410A	Yes	—	—	Yes	142
7411A	Yes	Yes	Yes	—	132
A123	—	Yes	—	Yes	146
A144	—	Yes	—	—	146

## Dividers and Auxiliary Equipment

Model	Basic Uncertainty	Stability	Input Range	Page
Y5020	$\pm 0.01\%$	0.002% in 6 months	0 to 20A	117
720A	0.1 ppm	1.0 ppm/year	0 to 1100V	124
721A	—	—	4000:1 Ratio	124
750A	10 ppm	10 ppm/year	1.1 to 1100V	123
752A	0.2 ppm - 10:1 0.5 ppm - 100:1	—	1100V	123
845AB	2%	0.15 $\mu$ V/HR	1.0 $\mu$ V to 1000V	125
845AR	3%	0.15 $\mu$ V/HR	1.0 $\mu$ V to 1000V	125

## AC/DC Transfer Standards

Model	Volts	Current	AC/DC Difference	Frequency Range	Page
A40	—	10 mA to 5A	0.02% with 540B	5 Hz to 100 kHz	127
A40A	—	10A and 20A	—	5 Hz to 50 kHz	127
A55	0.5 to 50V	—	0.05% to 0.5%	1 MHz to 50 MHz	127
540B	To 1000V	With A40, A40A	0.01%	5 Hz to 1 MHz	127

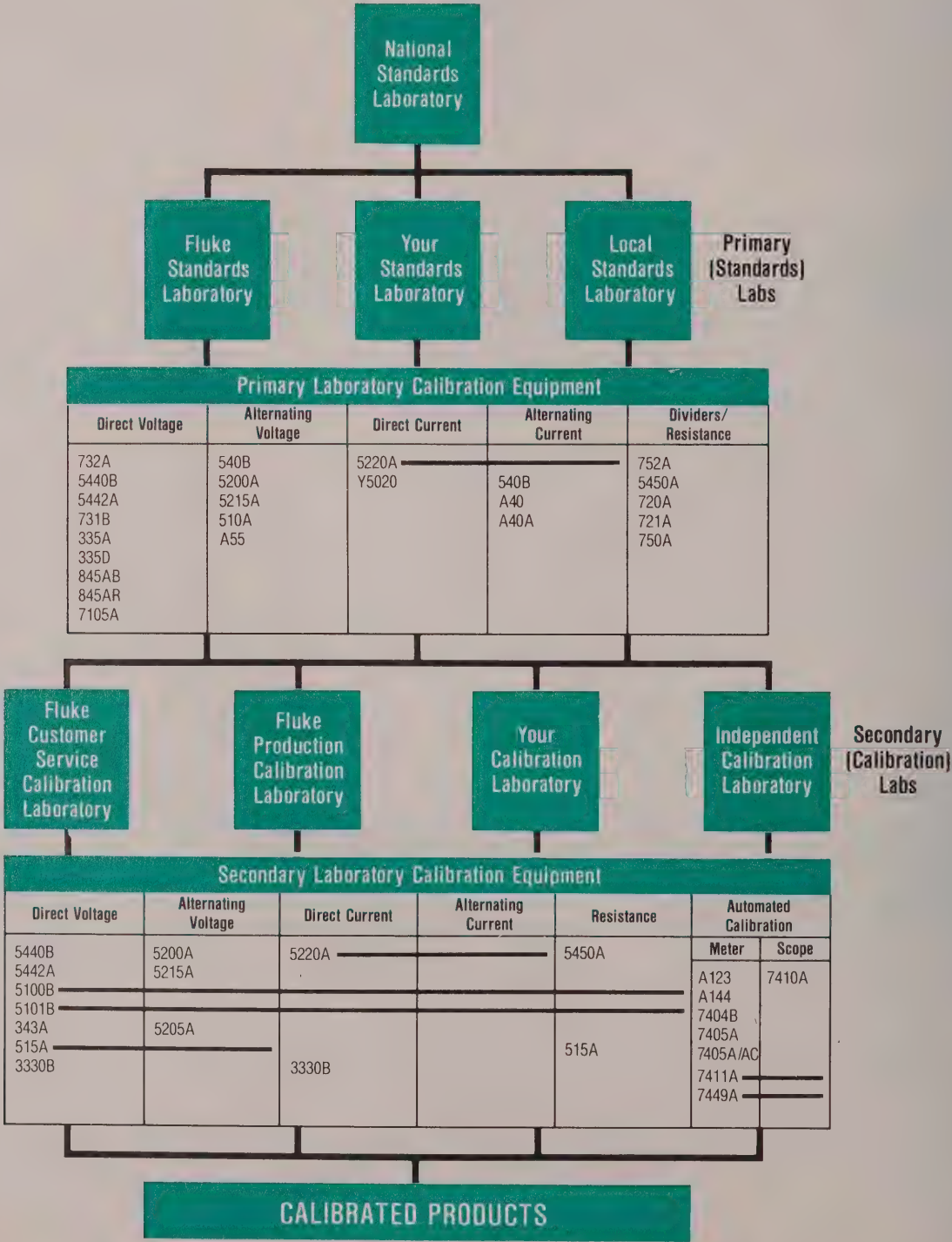


# APPLICATIONS

## Using the Applications Road Map to Calibration

The chart below shows the traceability chain and how Fluke calibration products are used. Products are shown as having applications in primary standards labs, secondary calibration labs,

or both. Fluke also has a variety of automated, computer-aided solutions to your calibration needs. Find the position of your lab on the chart then refer to the box below for the applicable products. Your local Fluke Sales Engineer would be glad to assist you in matching your needs with specific products.



### Introduction

Calibration is a dynamic discipline which requires sophisticated instrumentation, professional practice of metrology, and continuing improvements in efficiency and capability. Fluke has been a leader in the calibration business for over 30 years, introducing new products to make your task easier, while maintaining a reputation for high accuracy, stability, and product line integrity. Fluke calibrators have been researched and developed to meet your specific requirements for calibration capability.

	Multimeter Calibration	Direct Voltage Calibration	Alternating Voltage Calibration	Direct Current Calibration	Alternating Current Calibration	Resistance Calibration
5440B		•				
5442A		•				
5100B	•	•	•	•	•	•
5101B	•	•	•	•	•	•
5200A			•			
5450A						•
515A	•	•	•			•
335A		•				
335D		•				
343A		•				
3330B		•		•		
7105A		•				

### Accuracy and Uncertainty

Most calibration instruments include a specification called "accuracy." This is a statement of the largest allowable error expressed as a percentage of an absolute value. This number is properly called "uncertainty" because it is the allowed deviation from the nominal; it is a small number, where accuracy would be a large number. (Accuracy could be considered 1 - % uncertainty.)

Uncertainty can be a difficult specification to interpret because there are four accepted accuracy statements that can be combined in several different ways:

- Percent of output
- Percent of full scale
- Number of digits
- Number of units (e.g., microvolts)

This specification can be even further obscured through the use of various terms: percent, ppm, digits, microvolts, etc.

### Percent and PPM

Calibrator and meter uncertainty specifications are usually given as either percent or parts per million (ppm). These are interchangeable concepts. We have chosen to use the term "ppm" for the most part, mainly to make the numbers more easily readable by reducing the number of zeros. This table will give you an idea of how they relate:

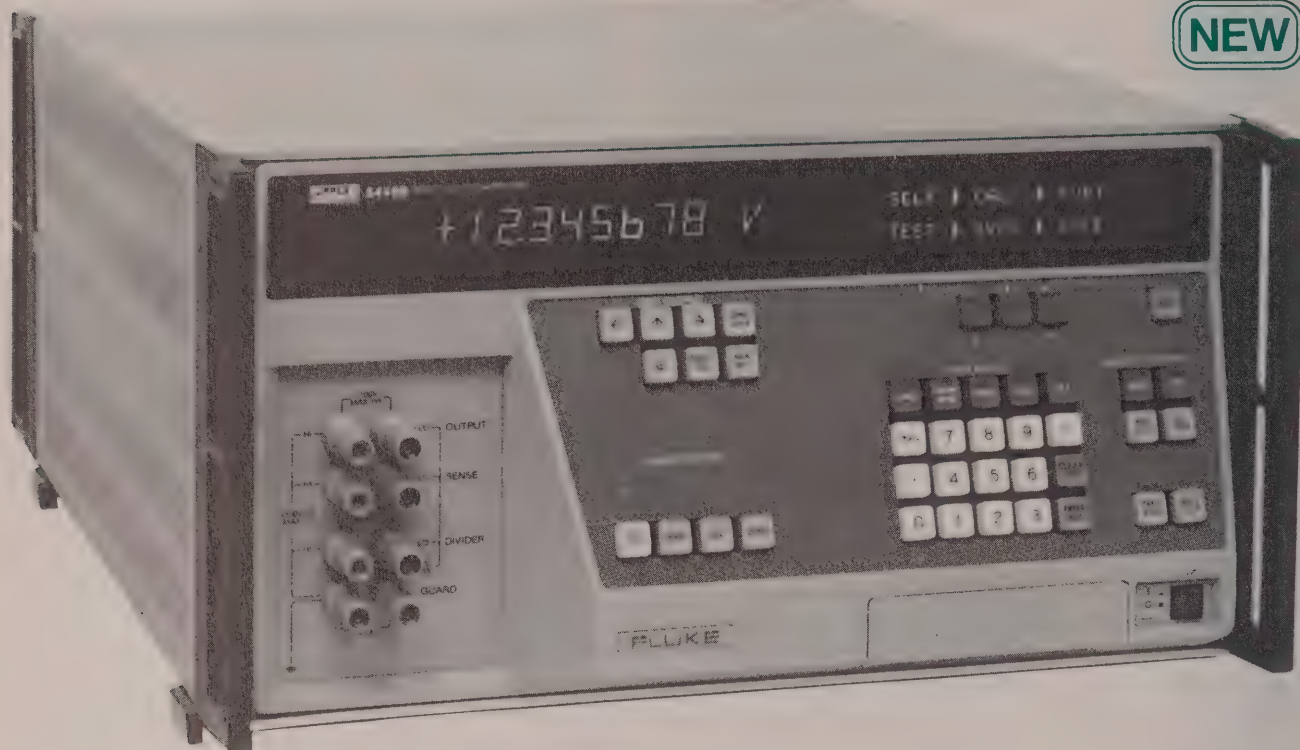
0.1% = 1000 ppm  
 0.01% = 100 ppm  
 0.001% = 10 ppm  
 0.0001% = 1 ppm

An easy memory aid to use is 0.01% and 100 ppm. Reverse the order of the numbers in 0.01% and it comes out as 100 ppm.



# CALIBRATORS

## 5440B/5442A

**NEW**

**5440B**

### 5440B & 5442A Direct Voltage Calibrators

- Highest available accuracy
- Full accuracy over extended temperature range of 10°C
- Completely automatic internal calibration, no mechanical adjustments
- Simplified 5-minute external calibration to traceable standards
- Test procedure memory and Procedure Storage Module for single button test setup (5440B only)
- Completely programmable through the IEEE-488 interface
- RS-232-C interface for printer output of calibration constants and instrument test results
- Bright vacuum-fluorescent displays for high visibility at all angles

The 5440B and 5442A are programmable direct voltage calibrators with an output voltage range of zero to 1100 volts and uncertainty specifications on the 10 volt range of 3 and 4 ppm respectively, referred to national standards.

The 5440B and 5442A are equipped with bright vacuum-fluorescent displays for clear visibility at any viewing angle. Even inexperienced operators find the 5440B and 5442A easy to use because the 40-

character, alphanumeric display provided in addition to the numeric output display makes operating instructions and error messages clear and readable in engineering units and English language messages instead of coded numerics. For semi-automated testing, the 5440B allows a complete test sequence of up to 60 steps to be stored in the internal Procedure Storage memory and recorded for later use in the interchangeable, plug-in Procedure Storage Modules. A test sequence is recalled and executed one step at a time with each touch of the NEXT STEP key.

The differences between the 5440B and the 5442A are in the operating features. The 5442A does not have the Procedure Storage Module nor does it have the boost capability for driving the 5205A Precision Power Amplifier and 5220A Transconductance Amplifier in system applications. The rear output terminals found on the 5440B as a standard feature are available for the 5442A as an option. Both instruments have outstanding accuracy specifications and the capability for operating at full rated accuracy over a temperature range of  $\pm 5^{\circ}\text{C}$  from the calibration temperature, making them well-suited for operation in a production environment as well as in a standards lab. Both instruments are completely programmable via the IEEE-488 interface which is included at no extra cost.

The outstanding accuracy specifications for the 5440B and 5442A are easily maintained in any lab by performing the simple, automatic calibration procedures which store the calibration constants in non-volatile EAPROM solid-state memory. No hardware adjustments are required. The Fluke 732A DC Reference Standard combined with the Fluke Direct Volt Maintenance Program and the Fluke 752A Reference Divider, provide the highest accuracy reference standards available for this periodic calibration.

## Specifications

Specifications apply to 5440B and 5442A unless otherwise noted.

**Output Voltage:** 0 to 1100V

**Output Current:** 0 to 25 mA

### 5440B:

**Output Uncertainty Compared to Calibration Standards,  $\pm 5^{\circ}\text{C}$**

Range	Uncertainty Specification: $\pm$ (PPM of Output + Microvolts)			
	30 Days	90 Days	180 Days	1 Year
0V to 11V	$1.5 + 5 \mu\text{V}$	$2.0 + 5 \mu\text{V}$	$2.5 + 5 \mu\text{V}$	$3.5 + 5 \mu\text{V}$
11V to 22V	$1.5 + 8 \mu\text{V}$	$2.0 + 8 \mu\text{V}$	$2.5 + 8 \mu\text{V}$	$3.5 + 8 \mu\text{V}$
22V to 275V	$2.5 + 100 \mu\text{V}$	$3.5 + 100 \mu\text{V}$	$4.5 + 100 \mu\text{V}$	$6.0 + 100 \mu\text{V}$
275V to 1100V	$2.5 + 400 \mu\text{V}$	$3.5 + 400 \mu\text{V}$	$4.5 + 400 \mu\text{V}$	$6.0 + 400 \mu\text{V}$
Divided Output				
0-220 mV	$4 + 0.5 \mu\text{V}$	$5 + 0.5 \mu\text{V}$	$6.5 + 0.5 \mu\text{V}$	$10 + 0.5 \mu\text{V}$
0.22-2.2V	$3 + 1 \mu\text{V}$	$4.5 + 1.0 \mu\text{V}$	$6 + 1.0 \mu\text{V}$	$8 + 1.0 \mu\text{V}$

### 5442A:

**Output Uncertainty Compared to Calibration Standards,  $\pm 5^{\circ}\text{C}$**

Range	Uncertainty Specification: $\pm$ (PPM of Output + Microvolts)			
	30 Days	90 Days	180 Days	1 Year
0V to 11V	$2.5 + 5 \mu\text{V}$	$3 + 5 \mu\text{V}$	$4.5 + 5 \mu\text{V}$	$6.5 + 5 \mu\text{V}$
11V to 22V	$2.5 + 8 \mu\text{V}$	$3 + 8 \mu\text{V}$	$4.5 + 8 \mu\text{V}$	$6.5 + 8 \mu\text{V}$
22V to 275V	$3 + 100 \mu\text{V}$	$3.5 + 100 \mu\text{V}$	$5 + 100 \mu\text{V}$	$7 + 100 \mu\text{V}$
275V to 1100V	$3 + 400 \mu\text{V}$	$4 + 400 \mu\text{V}$	$5.5 + 400 \mu\text{V}$	$8 + 400 \mu\text{V}$
Divided Output				
0-220 mV	$6 + 0.5 \mu\text{V}$	$7 + 0.5 \mu\text{V}$	$9 + 0.5 \mu\text{V}$	$12 + 0.5 \mu\text{V}$
0.22-2.2V	$4 + 1 \mu\text{V}$	$6 + 1.0 \mu\text{V}$	$8 + 1.0 \mu\text{V}$	$11 + 1.0 \mu\text{V}$

**Uncertainty of Calibration Standards Compared to National Standards**

Range	Uncertainty of Standards
0V to 11V	1.5 PPM
11V to 22V	1.5 PPM
22V to 275V	1.7 PPM
275V to 1100V	2.0 PPM
0V to 220 mV	4.0 PPM
0.22 to 2.2V	2.0 PPM

## Output Uncertainty Compared to National Standards

The output uncertainty compared to national standards for the 5440B and 5442A are defined as the algebraic sum for each range of the output uncertainty compared to calibration standards and the uncertainty of the calibration standards compared to national standards. The specifications for uncertainty of calibration standards listed above are those for the Fluke 732A and Fluke 752A. If other standards are used, the uncertainty of those standards must be substituted.

### Output Stability

Specifications apply for initial stabilization of two hours, constant ambient temperature of  $\pm 1^{\circ}\text{C}$ , constant line voltage, constant load, and measurement bandwidth of 0.1 Hz to 1 Hz.

Range	$\pm$ (PPM of Setting + Floor)		
	10 Minutes	24 Hours	30 Days*
0V to 11V	$0.2 + 2 \mu\text{V}$	$0.3 + 3 \mu\text{V}$	$1.5 + 3 \mu\text{V}$
11V to 22V	$0.2 + 3 \mu\text{V}$	$0.4 + 4 \mu\text{V}$	$1.5 + 4.5 \mu\text{V}$
22V to 275V	$0.3 + 40 \mu\text{V}$	$0.3 + 50 \mu\text{V}$	$1.5 + 60 \mu\text{V}$
275V to 1100V	$0.3 + 200 \mu\text{V}$	$0.3 + 200 \mu\text{V}$	$1.5 + 300 \mu\text{V}$
Divided Output			
0 mV to 220 mV	$0.5 + 0.2 \mu\text{V}$	$0.5 + 0.2 \mu\text{V}$	$2 + 0.3 \mu\text{V}$
0.22V to 2.2V	$0.5 + 0.2 \mu\text{V}$	$0.5 + 0.5 \mu\text{V}$	$2 + 0.7 \mu\text{V}$

\*For best results, use internal calibration for periods exceeding one day.

## Absolute and Relative Uncertainty Specifications

Calibration instrument specifications are related to the accuracy of the standards used to calibrate them. For example, the 5440B and 5442A absolute uncertainty specifications account for the 752A Reference Divider). The calibrators have a set of uncertainty specifications relative to the 732A, and the uncertainty specifications of the 732A are relative to national standards. The two uncertainties must be added together to determine the "absolute" uncertainty of the 5440B or 5442A, that is, the uncertainty relative to national standards. Relative uncertainty specifications allow you to determine the absolute uncertainty of a calibrator when it is calibrated with other than the manufacturer's specified standards. If you use a different set of standards, you will need to know what contribution those standards (or process) make.

### Temperature Coefficient of Output

These specifications apply for ambient temperatures outside the  $\pm 5^{\circ}\text{C}$  range of the uncertainty specifications listed earlier.

Range	$\pm$ (PPM of Setting) per $^{\circ}\text{C}$			
	0-10 $^{\circ}\text{C}$	10-30 $^{\circ}\text{C}$	30-40 $^{\circ}\text{C}$	40-50 $^{\circ}\text{C}$
0V to 11V	0.15 ppm	0.1 ppm	0.4 ppm	1.0 ppm
11V to 22V	0.15 ppm	0.1 ppm	0.4 ppm	1.0 ppm
22V to 275V	0.2 ppm	0.2 ppm	0.6 ppm	1.5 ppm
275V to 1100V	0.2 ppm	0.2 ppm	1.0 ppm	1.5 ppm
Divided Output				
0 to 220 mV	0.5 ppm	0.5 ppm	0.5 ppm	1.2 ppm
0.22V to 2.2V	0.5 ppm	0.5 ppm	0.5 ppm	1.2 ppm

### Linearity

These specifications apply for the ambient temperature range of  $15^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  within  $\pm 5^{\circ}\text{C}$  of the external calibration temperature.

Range	$\pm$ (PPM of Output + Microvolts)
0 mV to 220 mV	$0.5 \text{ ppm} + 0.2 \mu\text{V}$
0.22V to 2.2V	$0.7 \text{ ppm} + 0.3 \mu\text{V}$
0V to 11V	$0.5 \text{ ppm} + 1.5 \mu\text{V}$
11V to 22V	0.5 ppm
22V to 275V	$0.5 \text{ ppm} + 40 \mu\text{V}$
275V to 1100V	1.0 ppm

### Resolution

Range	Resolution	Maximum Setting	Maximum Load or Output Resistance
0V to 11V	$1 \mu\text{V}$	11.000000V	25 mA
11V to 22V	$1 \mu\text{V}$	22.000000V	25 mA
22V to 275V	$10 \mu\text{V}$	275.00000V	25 mA
275V to 1100V	$100 \mu\text{V}$	1100.0000V	25 mA
Divided Output			
0 to 220 mV	$0.01 \mu\text{V}$	220.00000 mV	495 $\Omega$
0.22V to 2.2V	$0.1 \mu\text{V}$	2.2000000V	450 $\Omega$



# CALIBRATORS

## 5440B/5442A

### Output Noise

Range	Bandwidth	
	0.1 Hz to 10 Hz	10 Hz to 10 kHz
0 mV to 220 mV	0.1 $\mu$ V	5 $\mu$ V
0.22V to 2.2V	0.2 $\mu$ V	15 $\mu$ V
0V to 11V	1.5 $\mu$ V	30 $\mu$ V
11V to 22V	3.0 $\mu$ V	50 $\mu$ V
22V to 275V	35 $\mu$ V	150 $\mu$ V
275V to 1100V	100 $\mu$ V	300 $\mu$ V

### Output Settling Time

Time to settle within a given uncertainty band of final value, for a change in programmed output within a given range.

Range	$\pm$ Parts per Million of Change*		
	3 seconds	5 seconds	10 seconds
0 mV to 220 mV, 0.22V to 2.2V, 0V to 11V, and 11V to 22V	7 ppm	2 ppm	0.5 ppm
22V to 275V 275V to 1100V	7 ppm	2 ppm	3 ppm

\* Add 0.5 seconds for any change in range up to 22V, 1.0 second for a change from 22V up, and 0.5 seconds for a change from STBY to OPER.

**Line Regulation:** Changes less than  $\pm 0.1$  ppm of range for  $\pm 10\%$  change from nominal line voltage

**Load Regulation:** Less than  $\pm 0.1$  ppm change of output for change from no-load to full-load or from full-load to no-load for output load impedances greater than 80 ohms

**Common Mode Rejection:** Greater than 140 dB for frequencies from dc to 400 Hz

**Temperature:** 0°C to 50°C, operating, except accuracy is degraded above 40°C due to loss of oven regulation; -40°C to +75°C non-operating

**Relative Humidity:**  $\leq 90\%$  to 30°C except accuracy is degraded above 80%,  $\leq 70\%$  to 40°C,  $\leq 40\%$  to 50°C

### Vibration

Frequency	Force	Double Amplitude
5 Hz to 15 Hz	0.7G at 15 Hz	0.06 inches
15 Hz to 25 Hz	1.3G at 25 Hz	0.04 inches
25 Hz to 55 Hz	3G at 55 Hz	0.02 inches

**Shock:** Eighteen 20G  $\frac{1}{2}$ -sinewave shocks

**Compliance With External Standards:** ANSI C39.5 Dec 1980 and IEC 348 Second Edition 1978

**EMI/RFI Review Standards:** FCC Rules Part 15, Subpart J; European Standard VDE 0871; MIL STD 461B

**EMI/RFI Conducted Emissions:** FCC Rules Part 15 Class J; European Standard VDE 0871; CISPR.11

**Radiated EMI/RFI Emissions:** Meets or exceeds all FCC and VDE requirements

**Power:** 100V, 110V, 115V, 120V ac  $\pm 10\%$  or 200V, 220V, 230V, 240V ac  $\pm 10\%$ , 50 to 60 Hz, 84W Standby, 145W nominal

**Size:** 61 cm L x 43 cm W x 24 cm H (24 in x 17 in x 9.4 in)

**Weight:** 30.2 kg (66.4 lb)

**Mounting:** Standard 19" EIA relay rack, tapped for attachment of slides; resilient feet provided for bench use

**Included**

5440B: Procedure Storage Module, IEEE-488 Interface, RS-232-C Printer Interface, Boost Interface, Rear Output

5442A: IEEE-488 Interface, RS-232-C Printer Interface

### Models

January 1985 prices

5440B Direct Voltage Calibrator ..... \$12,950  
5442A Direct Voltage Calibrator ..... 10,950

### Accessories (Also see page 230)

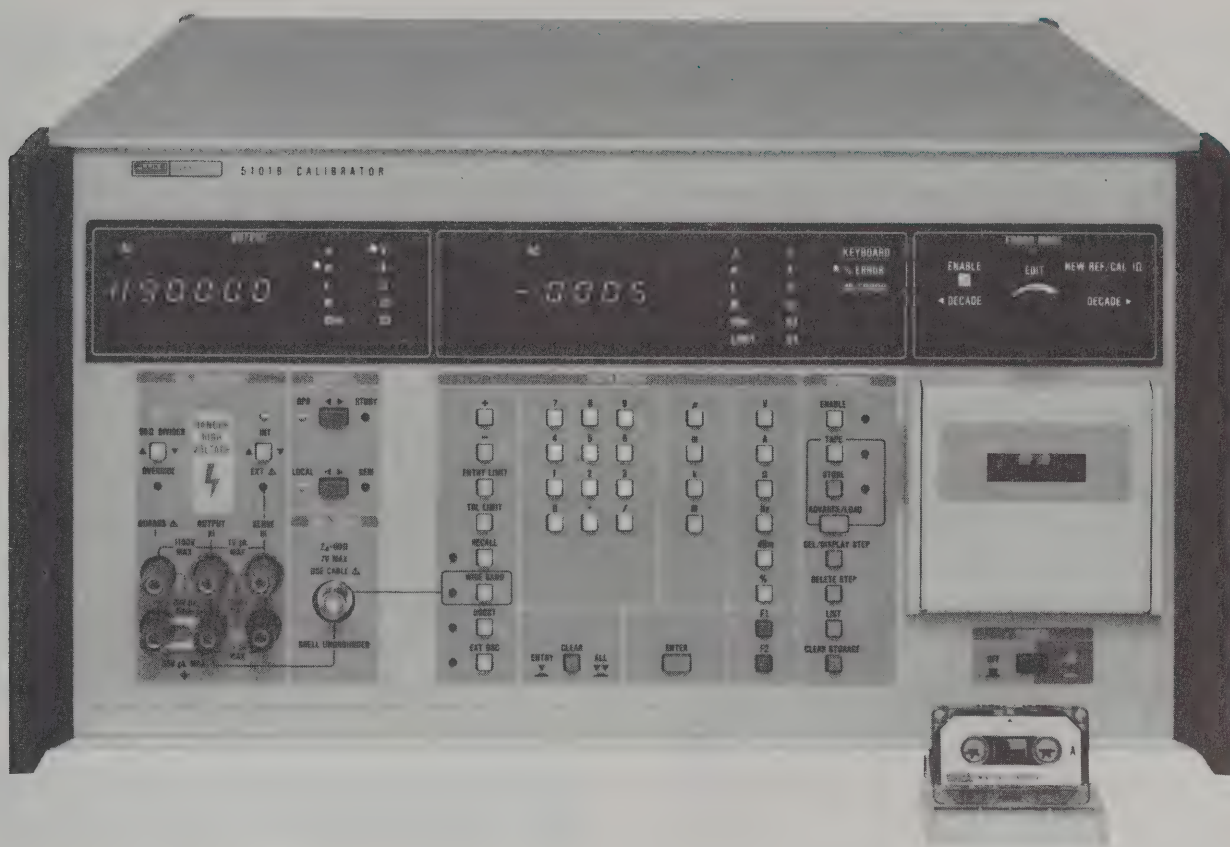
5440A-7001 Spare Procedure Storage Module ..... 210  
5440A-7002 Low Thermal EMF Plug-In Cables ..... on req.  
5440A-7003 Low Thermal Cables ..... 315  
732A DC Reference Standard ..... 2995  
752A Reference Divider ..... 3995  
M08-205-600 8 $\frac{1}{4}$ " Rack Mount Kit ..... 105  
M00-280-610 24" Rack Slide Kit  
(Requires M08-205-600) ..... 110  
5442A-01 Rear Output Option ..... on req.

### After-Warranty Service (See page 227)

SC1-5440A, per 90-day interval ..... 576  
SC1-5440B, per 90-day interval ..... 576

# CALIBRATORS

## 5100 Series B



5101B

### 5100 Series B Calibrators

- The world standard of multifunction calibrators
- Cost-effective multimeter calibration to 4½-digits
- Six functions: Direct or alternating volts or amps plus ohms
- Cassette tape drive available for storing procedures
- Cluster or workstation capability

The 5100 Series B Calibrators offer the convenience of calibrating precision meters that measure direct and alternating voltages and currents and/or resistance. Its microprocessor-based design speeds up repetitive testing — including semi-automated testing using cassette tapes.

### Optimized Calibration

The 5100 Series B provides all the voltages, currents, frequencies, and resistances needed to calibrate modern analog and digital multimeters. An inspection of the alternating voltage specifications will show voltages to 1100V rms are available to 1 kHz, but only lower voltages are provided at higher frequencies. This was done for several reasons: First, only a very few, mostly uncommon, voltmeters measure volt-hertz levels not provided by the 5100 Series B. Second, most of these may still be properly calibrated with the 5100 Series B. Third, the 5205A Power Amplifier may be used with the 5100B or 5101B to provide up to 1100V rms up to 50 kHz.

A modern DMM converts an alternating voltage input to a proportional direct voltage input with a circuit called a converter. The converter consists of two elements requiring recalibration: the input

attenuator and a wide-band operational amplifier. The attenuator is a passive resistive-capacitive network which attenuates high voltage signals to 1 volt or 0.1 volt (typical) before being applied to the amplifier. A check of the attenuation ratio (frequency response) is usually a calibration step that may readily be made with a high voltage at a low frequency and a low voltage at high frequency. Such voltages are provided directly by the 5100 Series B Calibrators. The amplifier is also calibrated for frequency response, but always at low levels regardless of frequency since its maximum input from the attenuator is typically one volt.

Calibrators with a wide volt-hertz dynamic range or high current, output, such as the Fluke 5200B and 5205A require increased power at the output to compensate for the effects of capacitive loading. This output power at high voltage and frequency is also presented to the operator and equipment! High power calibrators are a special case requiring highly skilled, experienced operators. Because recalibration of voltmeters does not generally require a wide dynamic range of voltage and frequency, to include such capability would add unnecessarily to the size, weight, complexity, and cost of the calibrator. A similar thing is true about high current. Therefore, the 5205A Power Amplifier and the 5220A Transconductance Amplifier are for use with the 5100 Series B for those who really need high power.

### 5100 Series B Increases Throughput

Three-fourths of the workload of meter calibration laboratories and production lines consists of analog and digital meters with 4½-digit or less resolution. There are hundreds of different meters in this category representing different manufacturers, with no standard format for meter specifications. Even meters from the same manufacturer are often specified differently. This creates a real problem for any cal lab manager.



# CALIBRATORS

## 5100 Series B

Until Fluke introduced the 5100 Series, calibration lab and production line managers were forced to write elaborate test procedures to convert the complex specifications into a step-by-step procedure for inexperienced workers. Or they could use expensive, highly-skilled technical people to perform the test without a procedure. These methods sometimes exceeded the initial cost of the instrument by three to five times over a 5-year period.

Operating the 5100 Series B is simple, making it easy to train your operators. And all data is entered via a calculator-type keyboard. No need to convert volts to dBm or dBm to volts, for example. And the 5100 Series B performs the mathematical computations associated with calculating the error of the unit-under-test (UUT) — in % or in dB. It then indicates to the operator whether the UUT passed or failed, according to its specified uncertainty and the magnitude of the error.

The 5100 Series B calibrates meters quickly and efficiently. It is no longer necessary to gather together a half-dozen separate calibration instruments requiring complex interconnection and operation. A single 5100 Series B does the whole job.

### 5101B Has System Features

The 5101B is designed for the user who needs the automated features of a large computer-based calibration system without the hardware and software costs of a large system.

A typical calibration procedure consists of forty or fifty separate steps. For most benchtop systems, each step must be loaded into the calibrator — an operation that is slow and prone to human error. The 5101B has a built-in cassette tape deck to store calibration procedures and step through them under microprocessor control.

Initially, the operator records the procedure on a cassette and uses a separate cassette for each procedure. Once recorded, the procedure can be repeated in a fraction of the usual time. Preparing the calibration tape and operating the 5101B, requires no special knowledge of computers or computer languages. Using a printer with the 5101B, you can document both the calibration procedure and the test results with a hard-copy record.

### Automated Calibration

Both the 5100B and 5101B can be used in computer-aided calibration applications by adding a Fluke touch screen controller and software package. Configurations available include benchtop clusters and mobile workstations. Preprogrammed calibration procedures are included in the software packages. Consult your local sales office for details.

### Extended Power and Current Capabilities

The 5205A Precision Power Amplifier and the 5220A Transconductance Amplifier will operate as an integrated system with either a 5100B, 5101B, or 5102B. The purpose is to extend the voltage and current sourcing capabilities beyond the basic built-in capabilities of the 5100 Series B Calibrators.

Voltage sourcing may be extended from 6 mA maximum to 100 mA maximum at 1100V for direct voltage. And alternating voltage sourcing may be extended from 20V at 50 kHz to 1100V at 50 kHz. Current sourcing may be extended from 2A to 20A.

A Y5000 Interface/Buffer is needed to integrate a 5205A and/or a 5220A with either a 5100B or 5101B. It connects to the rear panels and preserves the advantage of single-point control of calibration, automatic error calculation, entry limit protection, etc., inherent in the 5100 Series B or 5102B plus cassette tape storage of calibration steps in the 5101B.

## Specifications

### Direct Voltage

Range	Resolution	Maximum Current	Ripple and Noise (10 Hz to 3 kHz, NL to FL, RMS)
20 mV	0.1 $\mu$ V	Limited by 50 $\Omega$ output resistance or 25 mA using 50 $\Omega$ override	0.01% of setting +25 $\mu$ V
200 mV	1 $\mu$ V		
2V	10 $\mu$ V		
20V	100 $\mu$ V	25 mA/1000 pF	0.05% of setting (open to 20 k $\Omega$ )
200V	1 mV	10 mA/400 pF*	0.1% of setting (20 k $\Omega$ to full load)
1100V	10 mV	6 mA/400 pF*	0.05% of setting

\*100 mA/1500 pF with 5205A and Y5000

**Uncertainty:**  $\pm(0.005\%$  of setting  $+0.001\%$  of range  $+5 \mu$ V) for all ranges, for 6 months, 20°C to 30°C ambient, non-override

**Temperature Coefficient:** Above 30°C and below 20°C,  $\pm(5$  ppm of setting  $+1$  ppm of range  $+1 \mu$ V)/°C to 200V,  $\pm(5$  ppm of setting  $+2$  ppm of range)/°C, 200V to 1100V

**Short Term Stability:** (For 10 minutes from 0°C to 50°C)  $\pm(10$  ppm of setting  $+2$  ppm of range  $+5 \mu$ V) to 500V;  $\pm 25$  ppm of setting, 500V to 1100V

**Load Regulation:** (External Sense)  $\pm 10$  ppm from 2V to 1100V, no-load to full-load. (Internal Sense) same as external except full-load is 400 $\Omega$

### Alternating Voltage

Range*	Resolution	Maximum Current	Total Harmonic Distortion and Noise
20 mV	0.1 $\mu$ V	50 $\Omega$ source	Bandwidth of 10 Hz to 200 kHz, Distortion, line interference + noise including random spikes
200 mV	1 $\mu$ V		
2V	10 $\mu$ V		
20V	100 $\mu$ V	25 mA/ 1000 pF	<b>20V and Higher</b> 50 Hz to 10 kHz: 0.08% of output rms  <b>Below 20V</b> 50 Hz to 10 kHz: 0.05% of output + 10 $\mu$ V rms 10 kHz to 50 kHz: 0.08% of output + 20 $\mu$ V rms
200V	1 mV	10 mA/ 400 pF	
1100V	10 mV	6 mA/ 400 pF **	

\*Can be set in dBm where 0 dBm = 1 mW in 600 $\Omega$  = 0.7746V

\*\*200 mA/1500 pF with 5205A and Y5000

**Uncertainty:**  $\pm(0.05\%$  of setting  $+0.005\%$  of range  $+50 \mu$ V) from 50 Hz to 10 kHz and  $\pm(0.08\%$  of setting  $+0.008\%$  of range  $+50 \mu$ V) from 10 kHz to 50 kHz for 6 months, 20°C to 30°C ambient

**Frequencies Available (Hz):** 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, and 900 for all voltage ranges.

### Frequencies Available (kHz)

Voltage Range	1	2	3	4	5	6	7	8	9	10	20	30	40	50
110V to 1100V	●	△	△	△	△	△	△	△	△	△	△	△	△	△
20V to 110V	●	●	●	●	●	●	●	●	●	●	●	△	△	△
1 mV to 20V	●	●	●	●	●	●	●	●	●	●	●	●	●	●

△With 5205A and Y5000.

**Frequency Uncertainty:**  $\pm 3\%$ 

**Temperature Coefficient:** Above  $30^{\circ}\text{C}$  and below  $20^{\circ}\text{C}$   $\pm(20 \text{ ppm of setting} + 2 \text{ ppm of range})/^{\circ}\text{C}$  for amplitude,  $\pm 0.1\%/^{\circ}\text{C}$  for frequency  
**Short Term Stability:**  $\pm(0.01\% \text{ of range} + 10 \mu\text{V})$  for 10 minutes from  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$

**Load Regulation:** External Sense,  $\pm 200 \text{ ppm}$  from  $0.2\text{V}$  to  $1100\text{V}$ , no-load to full-load; Internal Sense, same as external except regulation for voltages  $< 0.2\text{V}$  is expressed as an output impedance of  $50\Omega$

**Direct Current**

Range	Resolution	Compliance Voltage	Ripple and Noise
200 $\mu\text{A}$	1 nA	0 to 10V	(0.05% of output + 0.01 $\mu\text{A}$ ) rms  Measured with 10 Hz to 10 kHz bandwidth including random spikes
2 mA	10 nA		
20 mA	100 nA		
200 mA	1 $\mu\text{A}$	0 to 2.1V	
2A*	10 $\mu\text{A}$		

\*20A with 5220A and Y5000

**Uncertainty:**  $\pm(0.025\% \text{ of setting} + 0.0025\% \text{ of range} + 0.01 \mu\text{A})$  for compliance voltage up to 1V. Add 0.002% of setting per volt above 1V rms. Applies for 6 months and  $20^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  ambient

**Temperature Coefficient:** Above  $30^{\circ}\text{C}$  and below  $20^{\circ}\text{C}$   $\pm(10 \text{ ppm of setting} + 2 \text{ ppm of range})/^{\circ}\text{C}$

**Short Term Stability:**  $\pm(50 \text{ ppm of setting} + 5 \text{ ppm of range} + 0.002 \mu\text{A})$  for 10 minutes from  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$

**Load Regulation:**  $\pm 20 \text{ ppm/volt}$  for change in output voltage from 1 volt to maximum compliance voltage

**Alternating Current**

Range	Resolution	Compliance Voltage	Total Harmonic Distortion and Noise
200 $\mu\text{A}$	1 nA	0 to 7V rms	(0.05% of output + 2 $\mu\text{A}$ ) rms  Distortion, line interference + noise, including random spikes
2 mA	10 nA		
20 mA	100 nA		
200 mA	1 $\mu\text{A}$	0 to 1.4V rms	
2A*	10 $\mu\text{A}$		

\*20A with 5220A and Y5000

**Uncertainty:**  $\pm(0.07\% \text{ of setting} + 0.01\% \text{ of range} + 0.02 \mu\text{A})$  for compliance voltage up to 1V rms (50 Hz to 1 kHz). Add 0.005% of setting per volt above 1V rms. Applies for 6 months in  $20^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  ambient

**Temperature Coefficient:** Above  $30^{\circ}\text{C}$  and below  $20^{\circ}\text{C}$   $\pm(25 \text{ ppm of setting} + 10 \text{ ppm of range} + 0.2 \text{ mA})/^{\circ}\text{C}$  for amplitude,  $\pm 0.1\%/^{\circ}\text{C}$  for frequency

**Short Term Stability:**  $\pm(0.014\% \text{ of setting} + 0.002\% \text{ of range} + 0.4 \mu\text{A})$  for 10 minutes from  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$

**Load Regulation:**  $\pm 50 \text{ ppm} + 20 \text{ nA/volt}$  for change in output voltage from 1 volt to maximum compliance voltage

**Resistance**

**Range:**  $1\Omega$  to  $10 \text{ M}\Omega$  in decade steps

**Uncertainty:**  $\pm 0.005\%$ , except  $\pm 0.02\%$  ( $1\Omega$ ),  $\pm 0.01\%$  ( $10\Omega$  and  $1 \text{ M}\Omega$ ), and  $\pm 0.05\%$  ( $10 \text{ M}\Omega$ ) assumes 4 terminal below  $100 \text{ k}\Omega$ . 6 mo  $20^{\circ}\text{C}$ - $30^{\circ}\text{C}$   
**Power Dissipation:** 1W maximum except  $100 \text{ mW}$  max ( $1 \text{ M}\Omega$ ) and  $10 \text{ mW}$  max ( $10 \text{ M}\Omega$ )

**Temperature Coefficient:** Above  $30^{\circ}\text{C}$  and below  $20^{\circ}\text{C}$ ,  $\pm 5 \text{ ppm}/^{\circ}\text{C}$  except  $\pm 10 \text{ ppm}/^{\circ}\text{C}$  ( $1\Omega$  and  $10\Omega$ ),  $\pm 10 \text{ ppm}/^{\circ}\text{C}$  up to  $40^{\circ}\text{C}$  ( $10 \text{ M}\Omega$ ), and  $\pm 50 \text{ ppm}/^{\circ}\text{C}$  above  $40^{\circ}\text{C}$  ( $10 \text{ M}\Omega$ )

**Extended Specifications****Direct Voltage (with 5205A)**

**Range:**  $\pm 100\text{V}$  to  $\pm 1100\text{V}$ , with 10 mV resolution

**Maximum Load:** 100 mA; 1500 pF

**Uncertainty:**  $\pm(0.07\% \text{ of setting} + 20 \text{ mV})$ , for 6 months,  $20^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  ambient

**Line-Related Noise:**  $\leq 50 \text{ mV rms}$

**Random Noise:**  $\leq 100 \text{ mV rms}$ , 1 MHz bandwidth

**Alternating Voltage (with 5205A)**

**Voltage Range:** 100V to 1100V rms, with 10 mV resolution

**Maximum Load:** 200 mA, decreasing linearly to 140 mA from 100 Hz to 50 Hz; 1500 pF

**Voltage Uncertainty:**  $\pm(0.08\% \text{ of setting} + 0.1\text{V})$  for 50 Hz to 10 kHz;  $\pm(0.12\% \text{ of setting} + 0.15\text{V})$  for 10 kHz to 50 kHz, for 6 months,  $20^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  ambient

**Frequency Range:** Discrete selections from 50 Hz to 50 kHz with 1 MSD resolution

**Frequency Uncertainty:**  $\pm 3\%$

**Harmonic Distortion and Noise:** 0.1% of setting from 50 Hz to 20 kHz, 0.2% of setting from 20 kHz to 50 kHz, for bandwidth of 10 Hz to 1 MHz

**Direct Current (with 5220A)**

**Range:**  $\pm 1\text{A}$  to  $\pm 19.9999\text{A}$ , with 100  $\mu\text{A}$  resolution

**Compliance Voltage:** 0 to 4V

**Uncertainty:**  $\pm(0.025\% \text{ of setting} + 1 \text{ mA})$ , for 6 months,  $20^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  ambient

**Ripple and Noise:** 0.05% of setting + 1 mA rms, 10 Hz to 3 kHz bandwidth

**Alternating Current (With 5220A)**

**Current Range:** 1A to 19.9999A rms, with 100  $\mu\text{A}$  resolution

**Compliance Voltage:** 0 to 3V rms

**Current Uncertainty:**  $\pm(0.07\% \text{ of setting} + 1 \text{ mA})$  rms from 50 Hz to 1 kHz,  $\pm(0.07\% \text{ of setting} + 1 \text{ mA}) \times \text{frequency}$  (in Kilohertz) from 1 kHz to 5 kHz, for 6 months,  $20^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  ambient

**Frequency Range:** Discrete selections from 50 Hz to 5 kHz with 1 MSD resolution

**Frequency Uncertainty:**  $\pm 3\%$

**Harmonic Distortion and Noise:**  $\pm(0.07\% \text{ of setting} + 1 \text{ mA})$  rms, for bandwidth of 10 Hz to 300 kHz

**Option Specifications****Wideband aV Option (-03)**

Option -03 is a high accuracy, low noise, extremely flat alternating voltage source which increases the frequency coverage of the 5100 Series B from its standard of 50 Hz to 50 kHz to 10 Hz to 10 MHz. This option enables the 5100 Series B to calibrate wideband meters. A dedicated front panel BNC connector provides ac output from 300  $\mu\text{V}$  ( $-57.5 \text{ dBm}$ ) to 3.1623V ( $+23 \text{ dBm}$ ) into 50 ohms impedance. The output is programmable from the front panel or I/O interface in volts or in dBm (where 0 dBm equals 1 mW into  $50\Omega$ ). Using a simple formula for calculation of a correction factor and the NEW REF feature, the wideband output can be directly programmed for dBm referenced to other impedances.

With the EDIT control the error of wideband meters can be calculated in % or in dB. With the EDIT control and NEW REF, you may test the frequency response of meters. This method provides a direct reading in percent or dB, ideal for making Bode plots.

**Range:** 10Hz to 10 MHz



# CALIBRATORS

## 5100 Series B

### Amplitude Uncertainty, at 1 kHz, Terminated in 50Ω\*

Voltage Range	Approx dBm Range	±[% of Setting + % of Range]
1V to 3.1623V	+13 to +23	0.25 + 0.25
0.31624V to 0.99999V	+3 to +13	0.5 + 0.25
0.1V to 0.31623V	-7 to +3	0.75 + 0.25
31.624 mV to 99.999 mV	-17 to -7	1.0 + 0.25
10 mV to 31.623 mV	-27 to -17	1.25 + 0.25
3.1624 mV to 9.9999 mV	-37 to -27	1.5 + 0.25
1 mV to 3.1623 mV	-47 to -37	1.75 + 0.25
300 μV to 0.99999 mV	-57.5 to -47	2.0 + 0.25

\*For 6 months, 20°C to 30°C ambient

### Amplitude Flatness\*

- 10 Hz to 30 Hz: ±0.3%
- 30 Hz to 1 MHz: ±0.25%
- 1 MHz to 5 MHz: ±0.25% above 1 mV, ±0.6% ≤1 mV
- 5 MHz to 10 MHz: ±0.6%

\*Using 1 foot of RG 58U cable terminated in 50Ω

**Temperature Coefficient:** Above 30°C and below 20°C ±(0.1 times basic accuracy)/°C for amplitude, ±0.25%/°C for frequency

**Harmonics:** -40 dB or lower relative to fundamental for each frequency except -32 dB above 5 MHz

**Spurious Outputs:** -50 dB or lower relative to fundamental for each frequency

**Frequency Resolution:** 1 MSD

**Frequency Uncertainty:** ±3%

### IEEE-488 Interface Option (-05)

This interface allows the 5100 Series to be used in a system compatible with IEEE Std 488-1978. System control is via the Fluke 1722A Instrument Controller or any host computer. Address coding is done using logic switches accessible on the rear panel. Data is transmitted bi-directionally in ASCII coded format. The repertoire is: SH1, AH1, T6, L4, SR1, RL1, DC1, and E2.

### Bit Serial Interface Option (-06)

Provides compatibility with EIA Standard RS-232-C or 20 mA current loops. Thirteen baud rates are available from 50 to 9600 and either one or two stop-bits can be set up. Selection is made via rear panel logic switches.

## General Specifications

**Shock and Vibration:** Meets requirements of MIL-T-28800 for Class 5, size and equipment

### Temperature

**5100B and 5102B:** 0°C to 50°C operating; -20°C to +65°C non-operating

**5101B:** (With tape cassette) +10°C to +40°C operating; +4°C to +50°C, non-operating. Without cassette: same as 5100B

**Relative Humidity:** ≤85% to 35°C, ≤70% to 40°C, ≤50% to 50°C

**Power:** 100, 110, 115, 120, 200, 220, 230, or 240 VA ±10%, 50 Hz to 60 Hz. 200VA (5100B) or 220VA (5101B) with all options

**Size:** 22.2 cm H x 60.3 cm W x 43.2 cm L (8.75 in H x 17 in W x 23.75 in L)

### Weight

**5100B:** 30.4 kg (67 lb) basic, 32.7 kg (72 lb) with all options

**5101B:** 32.7 kg (72 lb) basic, 34.9 kg (77 lb) with all options

**5102B:** 35.8 kg (79 lb) basic, 38.1 kg (84 lb) with all options

**Included:** Manual, power cord. Also one cassette tape with 5101B

## Models

January 1985 prices

<b>5100B</b> Calibrator .....	\$10,845
<b>5101B</b> Calibrator, with tape deck .....	13,055
<b>5102B</b> 5100B in portable case (military) .....	13,185
<b>5205A*</b> Power Amplifier .....	8950
<b>5220A*</b> Transconductance Amplifier .....	4300

\*Y5000 required when used with 5100 Series B Calibrator

## Options (for 5100B, 5101B, 5102B)

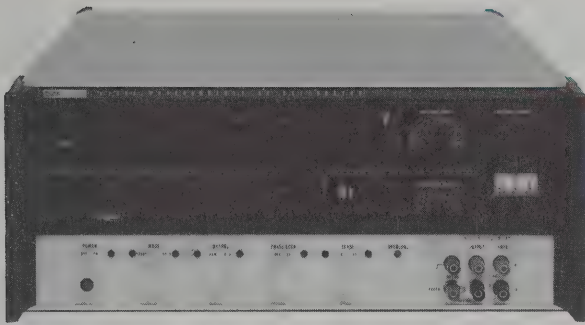
<b>5100A-03</b> Wideband AC Voltage .....	2440
<b>5100A-05</b> IEEE-488 Interface .....	590
<b>5100A-06</b> EIA RS-232-C Interface .....	590

## Accessories (Also see page 230)

<b>5100A-7003K</b> Fiberglass Case, 5100B/5101B .....	590
<b>5100A-7005K</b> Extender Kit .....	430
<b>M08-205-600</b> 8 3/4" Rack Adapter .....	105
<b>M00-280-610</b> 24" Rack Slides .....	110
<b>Y5000</b> Interface Buffer .....	535
<b>Y5001</b> Cable for 5205A and Y5000 .....	240
<b>Y5002</b> Cable for 5220A and Y5000 .....	215
<b>Y8021</b> 1m Cable for IEEE-488 bus .....	85
<b>Y8022</b> 2m Cable for IEEE-488 bus .....	95
<b>Y8023</b> 4m Cable for IEEE-488 bus .....	105
<b>Y8004</b> 1.5m Cable for RS-232 .....	105
<b>Y8007</b> 10-pack of cassettes for 5101B .....	150

## After-Warranty Service (See page 227)

<b>SC1-5100B</b> , per 90-day interval .....	884
<b>SC1-5101B</b> , per 90-day interval .....	980
<b>SC1-5102B</b> , per 90-day interval .....	952
<b>SC1-5205A</b> , per 90-day interval .....	760
<b>SC1-5220A</b> , per 90-day interval .....	220



5200A

### 5200A Precision Alternating Voltage Calibrator

- Seven voltage ranges from 1 mV to 1000V
- 6½-digit resolution (1,199,999 counts)
- Output frequencies from 10 Hz to 1 MHz
- Automated characterized operation available
- IEEE-488 system interface available
- Phase-lock input
- Quadrature output
- Completely guarded
- Short and overload protected

### A Proven Performer

The Model 5200A Alternating Voltage Calibrator is a precision high-performance alternating voltage source with proven reliability and exceptional stability and accuracy over a broad frequency range. It is specified over a wide 0°C to 50°C operating range for use in both laboratory and manufacturing environments. Amplitude is controlled in six ranges from 1 mV to 100V. Resolution to 1,199,999 counts yields 20% overrange capability with 1 nanovolt steps on the 1 mV range, up to 0.1 mV steps on the 100V range. Outputs from 100  $\mu$ V rms to 120V rms are provided, with up to 50 mA load current capability.

An additional 1000V range is included for front panel or remote interface control of a 5205A or 5215A Precision Power Amplifier.

Amplitude error measurement for voltmeter calibration is provided in two ranges,  $\pm 3\%$  and  $\pm 0.3\%$ . Error measurements can be resolved to 50 ppm.

Five frequency ranges are provided from 100 Hz to 1 MHz, with 119,999 count resolution for 20% overrange capability with 0.01 Hz steps on the 100 Hz range, up to 100 Hz steps on the 1 MHz range.

The oscillator of the 5200A may be phase locked to an external source to produce synchronous signals of precision amplitude and stability. Signal phase is locked within  $\pm 1^\circ$  of phase angle,  $+0.05^\circ/\text{kHz}$ , over a  $\pm 2\%$  band around the center frequency. This capability is essential for 60 Hz calibration.

A 3V pulse signal is provided for monitoring frequency with an external counter.

A quadrature output signal is provided which leads the fundamental signal phase by  $90^\circ$ . Amplitude varies from 1V to 10V rms, proportional to the fundamental signal output level on any range. This signal is useful for wattmeter calibration, and for research and development tasks that use the 5200A as a precision source.

External sensing may be selected, bringing rated accuracy to the load point bypassing losses in output leads.

Outputs are protected from overload by current limiting. Overload response time is typically 2 microseconds. When an overload is removed output recovers automatically to its previous level.

The 5200A is a fully guarded calibrator. This allows floating operation, and eliminates system ground loop problems. This is especially useful for calibrating non-guarded equipment.

### Remote Programming

The 5200A is remotely programmable in all functions except Power, Remote/Local, and Vernier Voltage Error. For any programmed amplitude, the output settles to its specified uncertainty within 0.5 seconds for frequencies above 100 Hz, and within 4 seconds for frequencies below 100 Hz. Program status flags are provided to indicate settling time and current limit conditions to the controller.

Either the 5200A-01 Parallel Remote Control Interface or the 5200A-05 IEEE-488 System Interface may be installed in the 5200A, for complete remote control of both the 5200A Calibrator and a 5205A or 5215A Power Amplifier.

The 5200A-01 Parallel Remote Control Interface provides excellent isolation between external system logic and internal calibrator circuitry. This isolation is typically  $10^9\Omega$  in parallel with 30 pF capacitance. This effectively attenuates external logic and ground noise better than 100:1 at 10 MHz.

Command data is segmented into 4-bit groups that can be programmed separately or simultaneously. Command data is stored both inside and outside the guard.

5200A-01 programming levels are compatible with TTL logic, and with contact closure:

Standard levels:

Logic 1 or true = 0 to +0.4 V

Logic 0 or false = +2.8V to +5.0 V

(For inverted logic levels, also order option 5200A-03.)

The 5200A-01 includes both standard and blank address matrix cards, and a mating connector.

The 5200A-05 IEEE-488 System Interface incorporates subsets SH1, AH1, T6, TE0, L4, LE0, SR1, RL0, PP0, DC2, and DT0 of IEEE Standard 488-1980. It allows complete remote programming of all functions except Power, Remote/Local, and Vernier Voltage Error. In addition, the 5200A-05 may be addressed for a 2-byte status response or serial polled for a 1-byte response. Status information includes Remote/Local, Standby/Operate, limits, settling time, and out-of-range instruction.

### Automated Characterized Operation

The established excellent stability and performance history of the 5200A Alternating Voltage Calibrator offer an opportunity for further reducing calibration uncertainty while greatly simplifying use by unskilled operators.

Characterization is a process of measuring a particular calibrator's uncertainties at selected points using traceable transfer standards and recording those uncertainties in a table. When the selected points are used, the portion of these uncertainties not due to the transfer standards or to the characterization process can then be added to (or subtracted from) the calibrator setting. In practice, this significantly reduces calibrator uncertainty.

If you know the characteristics of the calibrator design, you can then use mathematical interpolation methods for points other than those selected for characterization. While this will yield a significant improvement in uncertainty specifications, it can be complex and time consuming when done manually.

Option 5200A-800 is a software package that uses a Fluke 1722A or 1720A Instrument Controller to operate a 5200A Alternating Voltage Calibrator and a 5205A or 5215A Precision Power Amplifier. This software makes use of a stored characterization table and automatically interpolates for voltages and frequencies selected between characterization points.

The 5200A-800 controls all calibrator functions in a simplified manner with the touch-sensitive display of the 1722A or 1720A.



# CALIBRATOR

## 5200A

### Calibration

The 5200A is originally calibrated at the factory by instrumentation traceable to the U.S. National Bureau of Standards. Periodic traceable recalibration service is available through Fluke Technical Service Centers and Sales Representatives worldwide.

Fluke also offers 5200A characterization service as well as 540B characterization for customers doing their own 5200A characterization. The table of correction factors is supplied in written form, and on a disk compatible with the 5200A-800.

### Specifications

#### Amplitude Uncertainty

Basic instrument uncertainty is specified for 90 days. Characterized uncertainty requires optional 5200A-900 characterization, and is specified for 180 days. Both specifications are valid when operating in an ambient temperature between 18°C and 28°C after a 1-hour warmup.

Basic Instrument Absolute Uncertainty <sup>1</sup>			Characterized Uncertainty <sup>2</sup>		
Voltage Ranges	Frequency Hz	±(ppm setting + $\mu$ V)	Frequency Hz	±(ppm setting + $\mu$ V)	
				Relative	Absolute
1 mV <sup>3</sup> 10 mV	10-30	1000+10			
	30-20K	200+10			
	20K-100K	500+20			
	100K-1M	3300+30			
100 mV	10-30	1000+10	50-100	130+10	150+10
	30-20K	200+10	100-20K	125+10	145+10
	20K-100K	500+20	20K-50K	180+20	250+20
	100K-1M	3300+30	50K-100K	200+20	470+20
		±(ppm setting + ppm range)		±(ppm setting + ppm range)	
1V 10V 100V	10-30	1000+50	50-100	130+20	150+20
	30-20K	200+20	100-20K	125+15	145+15
	20K-100K	500+50	20K-50K	180+20	250+20
	100K-1M	3300+300	50K-100K	300+30	470+30
1000V <sup>4</sup>	10-30	1200+50	50-100	190+20	210+20
	30-20k	400+20	100-10k	180+20	180+20
	20k-50k	800+50	10k-20k	200+20	200+20
	50k-100k	1000+100	20k-50k	310+30	310+30

Notes:

- Traceable to U.S. NBS Standards. Includes transfer standards, dc reference source, and allowances for techniques, 90 days
- 180 days. Requires 5200A-900
- On 1 mV range, specification applies for measuring instruments with less than 2 MHz bandwidth.
- With 5205A or 5215A Power Amplifier

Characterized-Point Absolute Uncertainty, ±ppm*									
Voltage	Frequency, Hz								
	50	100	200	1k	2k	10k	20k	50k	100k
0.5	125	125	—	125	—	125	—	210	450
1	120	120	120	120	120	120	120	200	450
3	130	130	—	130	130	130	—	220	450
10	120	120	120	120	120	120	120	200	450
30	130	130	—	130	—	130	—	220	450
100	120	120	120	120	120	120	120	200	450
300	190	190	—	190	—	190	—	630	—
1000**	180	180	180	180	180	180	200	610	—

\* 180 days. Requires 5200A-900. Traceable to U.S. NBS Standards. Includes transfer standards, dc reference source, and allowances for techniques

\*\* With 5205A or 5215A Power Amplifier.

### Voltage Resolution

Range	Voltage Settings	Resolution
1 mV	0.100000 mV to 1.199999 mV	1 nV
10 mV	1.00000 mV to 11.99999 mV	10 nV
100 mV	10.0000 mV to 119.9999 mV	100 nV
1V	0.100000V to 1.199999V	1 $\mu$ V
10V	1.00000V to 11.99999V	10 $\mu$ V
100V	10.0000V to 119.9999V	100 $\mu$ V
1000*	100.000V to 1199.999V	1 mV

\*With 5205A or 5215A Power Amplifier

### Stability

Voltage Ranges	Frequency Hz	Stability <sup>1</sup> ±(ppm setting + ppm range) <sup>2</sup>	
		10 Minutes	180 Days
1 mV 10 mV	10 - 30	70 + 40	300 + 60
	30 - 20k	70 + 3 <sup>3</sup>	100 + 30
	20k - 100k	70 + 3	130 + 40
100 mV	10 - 30	70 + 40	300 + 60
	30 - 1k	70 + 3 <sup>3</sup>	70 + 40
	1k - 20k	70 + 3	100 + 30
	20k - 50k	70 + 3	120 + 50
1V 10V 100V	10 - 30	70 + 40	200 + 20
	30 - 20k	35 + 5 <sup>3</sup>	45 + 5
	20k - 50k	55 + 5	65 + 5
	50k - 100k	70 + 3	220 + 20
1000V <sup>4</sup>	10 - 100	0 + 50	200 + 0
	100 - 20k	70 + 5	200 + 0
	20k - 100k	70 + 5	400 + 0

Notes:

- Constant line, load, and temperature
- Total peak to peak random change in rms value
- For frequencies below 50 Hz, floor is 40 ppm of range
- With 5205A or 5215A Power Amplifier

**Temperature Coefficient:** For 0°C to 18°C and 28°C to 50°C, add  $\pm(0.025 \times \text{uncertainty})$  per °C below 18°C or above 28°C; for the 1000V range add  $\pm(0.03 \times \text{uncertainty})$  per °C

**Maximum Load:** 1 mV, 10 mV, 100 mV ranges: minimum 6000 $\Omega$  load impedance; 1V\*, 10V, 100V ranges: maximum load current 50 mA; 1000V range: maximum load current 200 mA

\*Minimum load impedance 50 $\Omega$  above 0.1 MHz

**Voltage Error Control:** Switch selectable OFF, or two ranges: 0 to  $\pm 0.3\%$  with 10 ppm resolution; 0 to  $\pm 3\%$  with 100 ppm resolution

## Settling Time

Frequency Hz	Settling Time,* Seconds
10 - 30	4 to 15
30 - 100	4
100 - 400	2
400 - 1M	1**

\*To within 100 ppm of change

\*\*Typically less than 0.5 second, except frequency range changes

**External Sense:** Switch selectable, internal or external, available on 1V, 10V, and 100V ranges.\* Output rises to less than 2.0V rms above selected level when sense lines are disconnected in external sense mode

\* Output impedance on 1 mV, 10 mV, and 100 mV ranges is less than 1.5Ω in series with 1.5 μH

## Frequency Performance\*

Range	Frequency Settings	Resolution** Hz	Uncertainty ±(% of Input + % of Range)
100 Hz	10.00 Hz to 119.99 Hz	0.01	1.0 + 0.1
1 kHz	1.000 kHz to 1.1999 kHz	0.1	
10 kHz	1.000 kHz to 11.999 kHz	1	
100 kHz	10.00 kHz to 119.99 kHz	10	
1 MHz	1.000 MHz to 1.999 MHz	100	3.0 + 0.3

\*90 days, 18°C to 28°C, after 1-hour warm-up

\*\*100 ppm of range

## Total Harmonic Distortion and Line-Related Noise\*

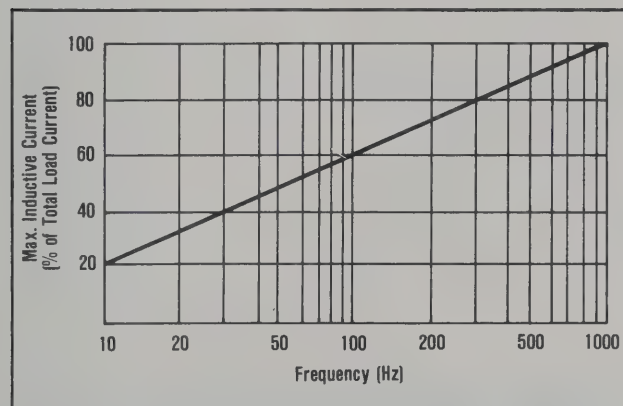
Frequency Hz	±(% of setting + μV rms)
10 - 100k**	0.04% + 10
100k - 500k	0.3% + 30
500k - 1M	1.0% + 30

\*Bandwidth 10 Hz to 10 MHz, and less than 15 mA output current except 1000V range. See 5205A or 5215A specifications

\*\*1V range is ±0.08% from 10 Hz to 15 Hz

**Maximum Capacitive Load:** 1000 pF on 1 mV-100V ranges, 1500 pF on 1000V range

**Maximum Inductive Load Current:** (Except 1000V range)



**Phase Lock Input:** 1V to 10V rms, useable down to 100 mV rms

**Phase Lock Accuracy:** ±3° below 30 Hz, and ±(1° + 0.05° per kHz) over a ±2% band around center frequency

## Quadrature Output:

**Amplitude:** 1V to 10V rms, ±10%, proportional to selected output voltage

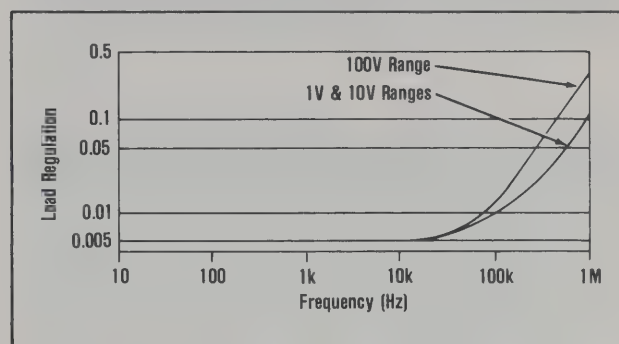
**Phase:** 10 Hz-40 Hz, 90° ±3°; 40 Hz to 1.2 MHz, 90° ±(1° + 0.03° per kHz)

**Minimum Load:** 3 kΩ impedance

**Current Limit:** Typical transition time, 2 μs. Recovery within specified settling time

**Volt-Hertz Product:** Output voltage x frequency ≤10<sup>7</sup>. Full 120V rms output is maintained up to 83.33 kHz. Maximum output voltage at 1.2 MHz is 8.33V rms

**Load Regulation:** 50 ppm of range, no load to full load, up to 10 kHz



## General Specifications

**Maximum Isolation Voltages:** (dc or peak ac) 500V, GUARD to chassis; 100V, LO to GUARD

**Temperature:** 0°C to +50°C operating, -40°C to +75°C storage

**Input Power:** Switch selectable, 100V, 115V, 200V, 230 VA, 100W

**Size:** 17.8 cm H x 43.2 cm W x 53.3 cm D (7 in x 17 in x 22.5 in)

**Weight:** 24.1 kg (53 lb)

**Includes:** Instruction manual, mating connectors

## Models

January 1985 prices

5200A Precision Alternating Voltage Calibrator	9950
5215A Precision Power Amplifier	8290
5200A/5215A Precision Alternating Voltage Calibration System	16,945
1722A Instrument Controller	7450

## Options

5200A-01* Parallel Remote Control Interface	1225
5200A-03 Logic Level Inversion (for 5200A-01)	205
5200A-05** IEEE-488 System Bus Interface	1850
5200A-800*** Automated Characterized Operation Software on req.	
5200A-900 Characterization of New-Purchase 5200A and 5215A	on req.
5200A-901 Characterization of Customer-Owned 5200A and 5215A	on req.

\*Cannot be used with 5200A-05

\*\*Cannot be used with 5200A-01

\*\*\*Requires 1722A or 1720A, and 5200A-900 or 5200A-901

## Accessories (Also see page 230)

M07-205-600 Rack Mount Kit for 5200A	100
M10-205-600 Rack Mount Kit for 5215A	105
M00-280-610 24" Rack Slides for rack adapter	110
Y1790 Rack Mount Kit with 24" Slides for 1722A	175
5200A-7015K Extender Board Kit	250

## After-Warranty Service (See page 227)

SC1-5200A, per 90-day interval	636
SC1-5215A, per 90-day interval	768

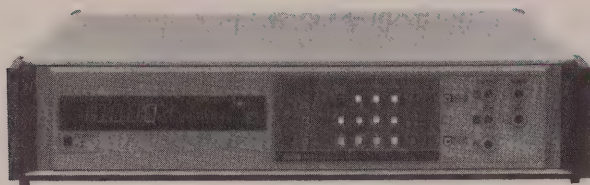
**FOR LEASE**

See page 238



# CALIBRATOR

5450A



5450A

## 5450A Resistance Calibrator

- 17 standard resistors in one enclosure
- Decade values from 1.0 ohm to 100 Megohms
- 1.9 multiples from 1.9 ohms to 19 Megohms
- True passive resistors for low noise and offset
- Midband accuracy of 8 ppm over 18°C to 28°C
- 4-wire or 2-wire operation
- Easy data entry for test lead compensation
- Automatic meter error calculation
- IEEE-488 programmable

The 5450A Resistance Calibrator is designed to verify the resistance-measuring accuracy of precision multimeters, either manually or as part of an automated calibration process. It complements the 5440A Direct Voltage Calibrator.

The 5450A provides cardinal point resistance values in decade steps from 1Ω through 100 MΩ and decade steps from 1.9Ω through 19 MΩ. Because full range readings of most digital multimeters start with the digits 19, the accuracy of readings near the full range may be checked using the 19-series resistors.

Each resistor differs from its nominal value by no more than 0.1%. But the precise value of each is known with a much higher degree of certainty. The known value of each is stored in EAROM and used for calibration purposes. Each value displayed has 1 ppm resolution.

Four-wire connections eliminate the effects of lead resistance or, for 2-wire operation, you may measure and store the lead resistance value and automatically subtract it from the value of each resistor. Connections to the instrument being calibrated may be made to the front panel terminals or to special rear panel binding posts that contribute very low thermal offset voltage errors.

Calibrating the 5450A consists of storing the right values of each resistor in the EAROM. Recalibration can be accomplished without removing the instrument covers, and may even be done remotely over the IEEE-488 bus. A rear panel switch insures integrity of calibration.

The 5450A displays the precise value of each selected resistor and can show the error of the instrument being calibrated — either in percent or in parts per million. All functions that can be controlled from the front panel may be controlled remotely via an IEEE-488 bus. No options are required to make the 5450A compatible with the bus; interface circuits are built in.

## Specifications

The following specifications apply when the 5450A is calibrated using a 10 kΩ standard resistor, the absolute value of which is known within ±2 ppm or better and using the ratio calibration method for calibrating resistor values from 10Ω through 100 MΩ. The 1.0Ω and 1.9Ω value must be calibrated by comparison to a 1Ω standard whose absolute value is known within ±5 ppm.

## Accuracy, For Rated Current, 4-Wire Connections

Nominal Resistance	Absolute Uncertainty (±ppm unless indicated)				Current Ranges	
	23°C ±1°C, ≤70% RH		23°C ±5°C, ≤70% RH			
	24 Hours	90 Days	90 Days	1 Year	Lower	Upper
Short	.1 mΩ	.1 mΩ	.1 mΩ	.1 mΩ	10 mA	500 mA
1Ω	50	62	75	110	10 mA	100 mA
1.9Ω	40	52	65	100	10 mA	75 mA
10Ω	18	20.5	25	33	10 mA	25 mA
19Ω	16	18.5	23	31	10 mA	25 mA
100Ω	7.5	9	11	16	10 mA	15 mA
190Ω	7	8.5	10.5	15.5	10 mA	15 mA
1 kΩ	5.5	7	8.5	13.5	700 μA	2.5 mA
1.9 kΩ	5	6.5	8	13	500 μA	2.5 mA
10 kΩ	5	6.5	8	13	50 μA	1 mA
19 kΩ	4.5	6	7.5	12.5	50 μA	1 mA
100 kΩ	6	7.5	9	14	5 μA	250 μA
190 kΩ	5.5	7	8.5	13.5	5 μA	250 μA
1 MΩ	7.5	10	11.5	19	5 μA	50 μA
1.9 MΩ	7.7	10	11.5	19	5 μA	25 μA
10 MΩ	16	24	26	50	.5 μA	5 μA
19 MΩ	20	28	30	56	.25 μA	2.5 μA
100 MΩ	65	90	120	200	.05 μA	.5 μA

\*Relative to National Standards such as U.S. Bureau of Standards

## General Specifications

Temperature: 0°C to 50°C, operating

Relative Humidity: ≤70% for rated accuracy

Power: 100, 120, 220, or 240V ac ±10%, 50 to 60 Hz ±5%, ≤50W

Size: 8.9 cm H x 43.2 cm W x 55.4 cm L (3.5 in x 17 in x 21.8 in)

Weight: 9.3 kg (20.4 lb)

Included: Instruction manual, line cord

## Model

January 1985 prices

5450A Resistance Calibrator ..... \$3995

## Option

5450A-600 Additional Manual ..... on req.

## Accessories (Also see page 230)

Y8021 1m Cable for IEEE-488 bus ..... 85

Y8022 2m Cable for IEEE-488 bus ..... 95

Y8023 4m Cable for IEEE-488 bus ..... 105

M00-260-610 18" Rack Slides ..... 105

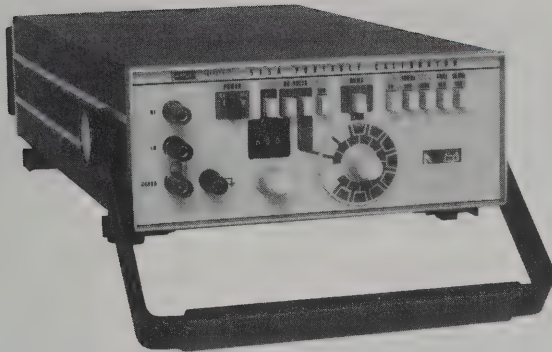
M00-280-610 24" Rack Slides ..... 110

Y8599 3½" Rack Adapter for Slides ..... 65

Y8598 3½" Rack Adapter with 22" Slides ..... 100

## After-Warranty Service (See page 227)

SC1-5450A, per 90-day interval ..... 152



515A

### 515A Portable Calibrator

- Precision, portable, 4½-digit calibration and 5½-digit verification where you need it
- Battery powered when disconnected from line power
- Lightweight and small size

The Model 515A Portable Calibrator is a precision voltage and resistance calibration source for on-site calibration of measuring instruments. The 515A provides dc voltage, ac voltage, and resistance standards in a unit only 3½ inches high by 8½ inches wide by 16 inches deep. The instrument weighs just 13 pounds, including the rechargeable battery pack, which eliminates warm-up delays after transit and allows 8-hour operation free of line power for true portability. The 515A's basic calibration accuracy is specified over a temperature range of 18°C to 28°C for a 1-year period, thus making it easy to use in production test and calibration lab environments without complex correction terms. The long calibration cycle also makes the 515A economical to own by minimizing maintenance overhead costs.

All 515A outputs are available at a single set of output terminals. In addition, terminals are available to allow guarding and shielding of test leads in critical test situations.

If the unit is connected to the ac line, the internal battery is placed on charge; otherwise the 515A automatically operates from the battery and its state of charge is indicated on the meter to the right of the panel.

The 515A can be used effectively to test a wide range of characteristics in measuring instruments. Here are a few of the many applications:

### Functions Checked

**DC Volts:** Input offset current, a-d linearity, absolute accuracy

**AC Volts:** Frequency response, converter linearity, residual noise, absolute accuracy

**Resistance:** Linearity, residual resistance, absolute accuracy

**General:** Zero offset and stability, autoranging, overranging

### Specifications

#### DC Voltage

##### Ranges

μV: 0 to 999 μV continuous (0.2 μV resolution)

1V: 0 to 1.0V in 0.1V steps

10V: 0 to 10V in 1V steps

100V: 100V cardinal point

**Accuracy:** (For 1 year, 18°C to 28°C, 30 min warm-up)

μV range: ±2 μV

1V, 10V, and 100V ranges: ±30 ppm or 30 μV of range, whichever is greater

**Output Current:** Function of source resistance, except 100V range which is limited at approximately 0.5 mA. No damage to instrument with short circuit on output

#### Source Resistance

μV, 1V, 10V ranges: 300Ω

100V range: <1Ω (up to 0.5 mA load)

#### AC Voltage

**Range:** 1V, 10V, 100V cardinal points

#### Output Frequencies

10V: 400 Hz, 4 kHz, 50 kHz

1V, 100V: 400 Hz

**Accuracy:** (For 1 year, 18°C to 28°C, 30 min warm-up)

1V: ±0.05%

10V: ±0.04% at 400 Hz and 4 kHz. ±0.1% at 50 kHz

100V: ±0.06%

**Frequency Accuracy:** ±1% except at 50 kHz ±5%

**Total Harmonic Distortion and Noise:** <0.03% (400 Hz and 4 kHz), <0.05% (50 kHz)

#### Output Current

1V, 10V output: 0 to 10 mA rms

100V output: 0 to 0.5 mA rms

#### Resistance

**Range:** 10Ω through 10 MΩ in decade steps + zero setting

**Accuracy:** (1 year, 18°C to 28°C, referred to "0"Ω position)

0Ω - Residual resistance is less than 0.15Ω

10Ω - 100Ω: ±0.06%

1 kΩ - 1 MΩ: ±0.015%

10 MΩ: ±0.075%

**Power Rating:** 0.2W or 100V (dc or rms), whichever is less

### General Specifications

**Temperature:** 0°C to 50°C, operating

**Power:** 100, 115, 200, 230V ac, ±10%, 50 to 440 Hz, <10W, or internal batteries. Eight hours operation from batteries when fully charged

**Weight:** 5.9 kg (13 lb)

**Size:** 8.9 cm H x 21.6 cm W x 40.6 cm D (3.5 in H x 8.5 in W x 16 in D)

**Included:** Manual, power cord, batteries

### Model

January 1985 prices

515A Calibrator ..... \$3880

### Accessories (Also see page 230)

M03-200-618 3" Rack Adapter, Dual .....	50
M03-200-619 3½" Rack Adapter, Offset .....	50
M03-200-620 Panel Mounting Kit .....	50
M03-203-700 Panel Protector .....	25

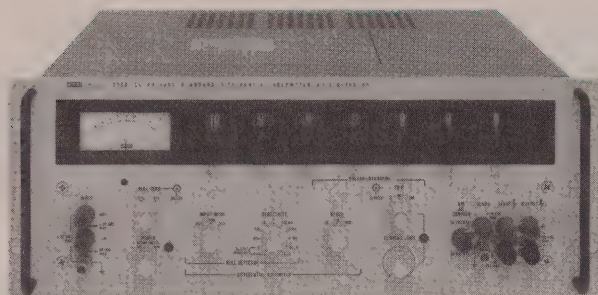
### After-Warranty Service (See page 227)

SC1-515A, per 90-day interval ..... 256



# CALIBRATORS

## 335A/335D



335A

### DC Voltage Calibrators/Null Detectors

- 0 to 1100V output, 0 to 50 mA
- 0.1 ppm resolution, seven decades
- Built-in null detector for differential voltage measurements
- 10 ppm basic accuracy (335D)
- 5 ppm basic stability per month (335D)
- Overvoltage and overcurrent protection

Combining accuracy with versatility, Models 335A and 335D provide the functions of a precision dc voltage standard with those of a differential voltmeter and high impedance null detector. The only practical difference between the 335A and the 335D is their accuracy and stability.

Both instruments provide 0.1 ppm resolution, using seven in-line decade switches.

### Specifications

**Voltage Ranges:** 10, 100, and 1000V with outputs as follows: 0 to 11.111110 (1  $\mu$ V steps), 0 to 111.11110 (10  $\mu$ V steps), 0 to 1111.1110 (100  $\mu$ V steps)

**Output Current:** 0 to 50 mA

**Accuracy of Output:** \*  $\pm$ (% of Setting +  $\mu$ V)

Range	90 Days	60 Days
	335A	335D
10V	0.002 + 10	0.001 + 10
100V	0.002 + 20	0.001 + 20
1000V	0.002 + 200	0.0015 + 200

\* Also measurement accuracy of 335A and 335D used as a differential voltmeter

**Stability of Output:**  $\pm$ (% of Setting +  $\mu$ V)

Range	335A	335D
10V	$\pm(0.001 + 10)/\text{mo}$ $+ (0.002 + 20)/\text{yr}$	$\pm(0.0005 + 7)/\text{mo}$ —
100V & 1000V	$\pm(0.001 + 20)/\text{mo}$ $\pm(0.002 + 40)/\text{yr}$	$\pm(0.0005 + 30)/\text{mo}$ —

**NOTE:** The accuracy and stability are absolute, relative to NBS standards, and include effects of stability, line regulation, load regulation, and calibration uncertainties under standard reference conditions of 23°C  $\pm$ 1°C and up to 70% relative humidity.

**Temperature Coefficient:** (0.0002% of setting + 1  $\mu$ V)/°C from 22°C to 0°C or 24°C to 50°C

**Overcurrent Protection:** Limits current at 1 mA to 60 mA via continuously variable front panel control

**Overvoltage Protection:** Trips output if voltage level exceeds setting of front panel controls. Continuously variable from 10% to 110% of each range

**Ripple and Noise:** 10V range,  $\leq 20 \mu$ V rms; 100V range,  $\leq 30 \mu$ V rms; 1000V range,  $\leq 40 \mu$  rms

**Settling Time:** Typically within 10 ppm of final output less than 20s after a range change

**Regulation:** 0.0002% of setting or 10  $\mu$ V for a 10% line voltage change or a full load change

**Common Mode Noise Rejection:**  $\geq 140$  dB from dc to 400 Hz, up to 700V rms or 1000V dc

**Isolation:** Either output terminal may be floated up to 1000V dc from chassis ground

**Remote Sense:** Separate terminals are provided for sensing the output voltage directly at the load

**Temperature:** 0°C to 50°C, operating

**Power:** 115 or 230V ac  $\pm$ 10%, 40 to 60 Hz, approximately 130 VA fully loaded

**Size:** 17.8 cm H x 48.2 cm W x 45.7 cm D (7 in H x 19 in W x 18 in D)  
**335A and 335D Weight:** 23 kg (50 lb)

**Mounting:** Standard 19" EIA relay rack, tapped for attachment of slides; resilient feet provided for bench use

**Included:** Manual, power cord

### Models

January 1985 prices

335A DC Voltage Calibrator/Null Detector	\$8590
335D DC Voltage Calibrator/Null Detector	9200

### Accessories (Also see page 230)

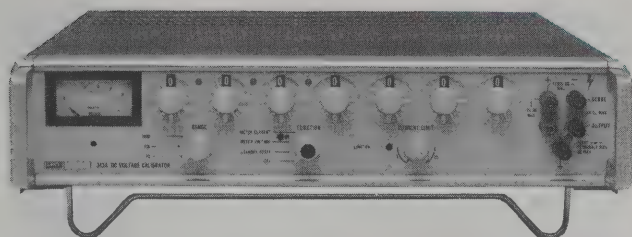
A60-01 17-20" Rack Slides ..... on req.

### After-Warranty Service (See page 227)

SC1-335A, per 90-day interval	616
SC1-335D, per 90-day interval	628

## CALIBRATOR

343A



343A

## 343A DC Voltage Calibrator

- 0 to 1100V output, 0 to 25 mA
- 0.1 ppm resolution, seven decades
- 20 ppm basic accuracy
- Stability better than 5 ppm/hour, 15 ppm/month

The 343A is a 7-digit instrument with a basic accuracy of 20 ppm and a resolution of  $1\ \mu\text{V}$  on the 10V range.

Cleanliness of the dc output is evident in the combined ripple and noise specifications of  $50\ \mu\text{V}$  rms from the 343A. Short term jitter and other random excursions are almost non-existent, less than 1 ppm.

A simple amplifier/comparator circuit is utilized to establish a convenient, variable, current limiter. Any maximum current output from 1 to 30 mA may be set via a front panel control. In addition to providing for current protection to the load, a failsafe "crowbar" protects the series-pass elements from damage should the total voltage across the elements exceed a safe level.

## Specifications

**Output Voltage:** 0 to 1100V dc

**Resolution:**  $1\ \mu\text{V}$  on 10V range,  $10\ \mu\text{V}$  on 100V range,  $100\ \mu\text{V}$  on 1000V range

**Accuracy, 90 Days**

10V Range:  $\pm 0.002\%$  of setting or  $\pm 0.0002\%$  of range\*

100V Range:  $\pm 0.002\%$  of setting or  $\pm 0.0001\%$  of range\*

1000V Range: Same as 100V range

\*Whichever is greater

**NOTE:** The above accuracies are absolute, relative to NBS standards, and include effects of stability, line regulation, load regulation, and calibration uncertainties under standard reference conditions of  $23^\circ\text{C} \pm 1^\circ\text{C}$  and up to 70% relative humidity after 30 minute warm-up. Apply for 90 days.

**Stability:**  $\pm\%$  of Setting or  $\pm\text{Microvolts}^*$

Time	10V Range	100V Range	1000V Range
Per Hour	0.0005% or $5\ \mu\text{V}$	0.0005% or $10\ \mu\text{V}$	0.0005% or $20\ \mu\text{V}$
Per Month	0.0015% or $15\ \mu\text{V}$	0.0015% or $25\ \mu\text{V}$	0.0015% or $50\ \mu\text{V}$
Per 6 Mo.	0.0025% or $30\ \mu\text{V}$	0.0025% or $40\ \mu\text{V}$	0.0025% or $60\ \mu\text{V}$

\*Whichever is greater

**Temperature Coefficient:**  $\pm(3\ \text{ppm of setting} + 0.1\ \text{ppm of range} + 2\ \mu\text{V})$  per degree Celsius from  $22^\circ\text{C}$  to  $15^\circ\text{C}$  or  $25^\circ\text{C}$  to  $35^\circ\text{C}$

**Regulation:**  $<0.0005\%$  of setting  $+25\ \mu\text{V}$  for a 10% line voltage change or a full-load to no-load change

**Isolation:** May be floated 500V dc from chassis

**Settling Time:** Within 15 ppm of final output in 5 seconds

**Overcurrent Protection:** Automatically limits output current at any preset level between 1 mA and 30 mA via continuously variable front panel control. Panel lamp illuminates during limiting

**Meter:** Switch-selectable to full range voltage or full range current

**Remote Sense:** Separate terminals are provided for sensing the output voltage directly at the load

**Temperature:**  $0^\circ\text{C}$  to  $50^\circ\text{C}$ , operating

**Power:** 115 or 230V ac  $\pm 10\%$ , 50 to 440 Hz, approximately 60 VA fully loaded

**Size:** 8.9 cm H x 43.2 cm W x 45.7 cm D (3.5 in H x 17 in W x 18 in D)

**Weight:** 10.43 kg (23 lb)

**Included:** Instruction Manual

## Model

January 1985 prices

343A DC Voltage Calibrator ..... \$4715

## Accessories (Also see page 230)

MEE-7001  $3\frac{1}{2}$ " Rack Adapter ..... 110

MEE-8078 18" Rack Slides for rack adapter ..... 125

MEE-8079 24" Rack Slides for rack adapter ..... 135

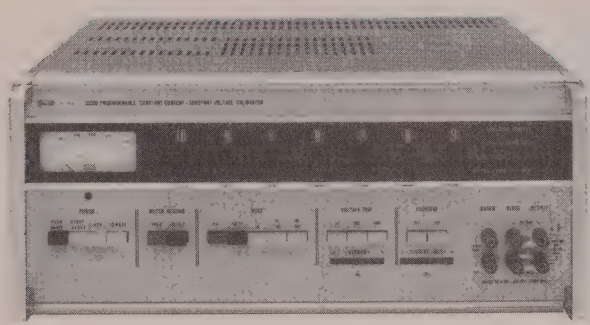
## After-Warranty Service (See page 227)

SC1-343A, per 90-day interval ..... 308



# CALIBRATOR

3330B



3330B

## 3330B Programmable DC Voltage & Current Calibrator

- Programmable output, voltage or current
- 0 to 1100V, programmable to 0.1 ppm resolution
- 0 to 111 mA, programmable to 0.1 ppm resolution
- Compliance voltage to 500V, 100 mA range
- Basic Accuracy of 30 ppm voltage, 60 ppm current
- Overcurrent, overvoltage protection

Model 3330B combines high dc accuracy with the programmability required for automated calibration systems. The unit may be programmed for analog dc outputs within 0.003% of command from 0 to  $\pm 1111$  V dc in three ranges. In addition to constant voltage outputs, the 3330B is a programmable constant dc current calibrator accurate to  $\pm 0.006\%$  of the programmed value.

One input line programs the voltage or current mode. Current output is 0 to 111 mA in three ranges using the same control lines as in the voltage mode.

All program input lines to the unit are applied to semiconductors, not relay coils that require driving currents. Thus, interface with DTL and TTL solid-state logic is possible. Logic 1 (0 to +.5V dc or contact closure) on any input line requires no current from the source; 2.5 mA of current sinking is the only requirement.

Full control of the instrument is possible from the front panel as well as by programming lines. Remote programming can be overridden at the front panel if desired.

## Constant-Current Specifications

- Analog Outputs**
- 1 mA Range: 0 to 1.111110 mA (0.1 nA steps)
  - 10 mA range: 0 to 11.111110 mA (1 nA step)
  - 100 mA range: 0 to 111.11110 mA (10 nA steps)
- Accuracy of Output:**  $\pm 0.006\%$  of programmed level or 0.0006% of current range\*
- Stability of Output:** 10 ppm of programmed level or 1 ppm of range per day, 30 ppm of programmed level or 6 ppm of range per month\*
- \*Whichever is greater
- NOTE:** Accuracy and stability apply at standard conditions described under constant voltage specifications
- Compliance Voltage:** Up to 1000V on 1 mA and 10 mA ranges. Up to 500V on 100 mA range
- Ripple and Noise:** For negative ground or floating operations, 20 nA on 1 mA range, 100 nA on 10 mA range, 1  $\mu$ A on 100 mA range.

## Constant-Voltage Specifications

- Analog Outputs**
- 10V range: 0 to 11.111110V (1  $\mu$ V steps)
  - 100V range: 0 to 111.11110V (10  $\mu$ V steps)
  - 1000V range: 0 to 1111.1110V (100  $\mu$ V steps)
- Accuracy of Output (% of Programmed Level)**
- 10V range:  $\pm 0.003\%$  or  $\pm 30 \mu$ V\*
  - 100V range:  $\pm 0.003\%$  or  $\pm 300 \mu$ V\*
  - 1000V range:  $\pm 0.003\%$  or  $\pm 3$  mV\*
- Output Current**
- 10V and 100V ranges: 0 to 100 mA any programmed level
  - 1000V range: 0 to 50 mA at any programmed level
- Stability of Output of Programmed Level)**
- 10V range: 5 ppm or 10  $\mu$ V/day; 15 ppm or 30  $\mu$ V/mo\*
  - 100V range: 5 ppm or 100  $\mu$ V/day; 15 ppm or 300  $\mu$ V/mo\*
  - 1000V range: 5 ppm or 1 mV/day; 15 ppm or 3 mV/mo\*
- NOTE:** Accuracy and stability apply for 90 days at standard reference conditions of 23°C  $\pm 1^\circ$ C, constant line voltage, up to 70% relative humidity, and constant external load. With uninterrupted operation for more than one hour at loads greater than 25 mA, the specified accuracy is  $\pm 0.005\%$  over an operating temperature range of 18°C to 28°C.
- \*Whichever is greater
- RMS Ripple and Noise**

Range	Up to 50 mA Load	Up to 100 mA Load
10V	60 $\mu$ V	100 $\mu$ V
100V	70 $\mu$ V	100 $\mu$ V
1000V	100 $\mu$ V	200 $\mu$ V

## General Specifications

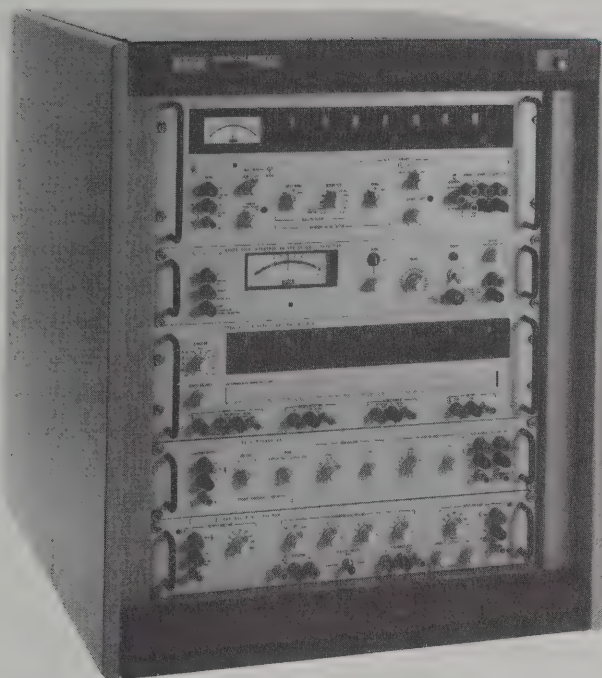
- Voltage Trip, Voltage or Current Operation:** Remote mode is programmable in 10% steps from 1% to 110% limit range. Local mode is continuously adjustable from 1% to 110% of range.
- Response Time:** (To within specs) 1, 10, 100 mA ranges is 500 ms typical, dependent on load resistance; 10V range is 60 ms; 100V range is 300 ms; 1000V range is 3s
- Input Power:** 115 or 230V ac  $\pm 10\%$ , 48 to 62 Hz, approximately 130 VA fully loaded
- Size:** 17.8 cm H x 43.2 cm W x 45.7 cm D (7 in H x 17 in W x 18 in D)
- Weight:** 26.3 kg (58 lb)
- Included:** Instruction Manual, power cord, mating connector for programming input

**Model** January 1985 prices  
3330B DC Voltage/Current Calibrator ..... \$9875

- Accessories (Also see page 230)**
- MEE-7003 7" Rack Adapter ..... 160
  - MEE-8078 18" Rack Slides for Rack Adapter ..... 125
  - MEE-8079 24" Rack Slides for Rack Adapter ..... 135

# CALIBRATOR

7105A



7105A

## 7105A DC Calibration Instrument Cluster

- Cost-effective, high accuracy calibration
- Self-calibrating
- Expandable for ac calibration

The 7105A is a calibration system composed of five Fluke standards-type instruments mounted in a single benchtop cabinet. The system is "self-calibrating" and lets you achieve calibration accuracy equal to that found in the most sophisticated standards laboratories. The 7105A is well known world-wide and is used extensively by electronic and electrical equipment manufacturers and government facilities.

Although the system is strictly for calibrating direct voltage sources, direct voltage meters, and the direct voltage value of resistors and dividers, the dc capabilities may be extended to ac calibration and measurement through the use of Fluke thermal transfer standards 540B, A55, A40, and A40A.

The instruments comprising the 7105A are:

- Model 335A DC Voltage Standard/Null Detector
- Model 845AR High Impedance Voltmeter/Null Detector
- Model 750A Reference Divider
- Model 720A Kelvin-Varley Divider
- Model 721A Lead Compensator

## Calibrate Voltage Sources and Voltmeters

Ultimate accuracy in voltage calibration is easily achieved using a two-step approach:

Step 1. Transfer the accuracy of the standard cells to the 10-volt output of a 732A Direct Voltage Reference Standard using a 720A Kelvin-Varley Divider and a null detector.

### Step 1 Error Limits

Number of Standard Cells (n)	Limits of Error*
n = 4	0.6 ppm
n = 5	0.5 ppm
n = 6	0.4 ppm
n = 7	0.4 ppm
n = 8	0.4 ppm
n = 9	0.3 ppm

\*Standard cell uncertainty not included

Step 2. Calibrate the output of the 335A DC Calibrator, or any very stable power supply, using the 732A, the 720A, a null detector, and a 750A Reference Divider which has its 10V, 100V, 1000V, and 1100V ratios specially calibrated.

The limits of error for different voltage ranges are shown in the table below for these conditions:

- The 732A was calibrated using nine standard cells.
- The self-calibration of the 720A and the calibration of the 750A at the 10V and 100V, and the 10V, 1000V, and 1100V ratios was performed immediately prior.
- Ambient temperature remains stable within  $\pm 1^\circ\text{C}$ .

### Step 2 Error Limits

Voltage Range	Limits of Error*
$\leq 10\text{V}$	$0.3 + (0.2 \div S)$ ppm
10V to 100V	3.3 to 1.5 ppm
100V to 1100V	4.3 to 2.5 ppm

\*Standard cell uncertainty is not included

S Setting of Fluke 720A division ratio (0 to 1.0)

Below 10V, better accuracy may be achieved by using a different configuration of the 7105A System.

## Calibrate Voltage Dividers

Using the 335A as a stable dc source and the 721A to compensate lead errors, a voltage divider may be checked. Specifications for the comparison are listed:

Absolute Linearity	0.1 ppm of input
Resolution	0.1 ppm of input
Input Taps	1.1 and 1.0
Maximum Input Volts	1.1 kV and 1.0 kV
Input Resistance	110 k $\Omega$ and 100 k $\Omega$
Power Coefficient	0.1 ppm of input/W
Temp Coefficient*	0.1 ppm of input/ $^\circ\text{C}$
Stability*	1 ppm/yr

\* 720A self-calibration removes linearity deviations caused by time or temperature

## Precision Differential Voltmeter

The system may be configured as a differential voltmeter obtaining 0.1 ppm resolution with the 720A Kelvin-Varley Divider. Both null detectors are used, one to compare the input voltage and one to continuously monitor standard cell EMF. Uncertainty is 5 ppm to 100V, to 20 ppm at 1.1 kV.

### Model

January 1985 prices

7105A DC Calibration System (includes 7105A-502) ..... \$22,565  
7105A-502K Cabinet, with leads, accessories ..... 1630



## Selecting Calibrators and Standards

When selecting calibrators and standards, the most important consideration is your applications for the instruments to be calibrated. Once the applications requirements for accuracy, precision, and stability are defined, you will know to what level of uncertainty the calibration must be performed and can determine which calibrators and standards are appropriate. Once rule-of-thumb ought to be followed: The calibration process should be as simple as your applications will allow. The use of primary level calibration instruments serves no useful purpose for tertiary level equipment. In addition, selection of calibrators should be based on your available time and ability to use professional metrology techniques in the detection, evaluation, and analysis of systematic and random errors encountered in the calibration process. Fluke provides you with a broad spectrum of calibrators and standards that enable you to optimize this trade-off to your best advantage.

The next consideration is whether your laboratory can maintain the environment required by the calibrators and standards you have determined are necessary for your calibration process. The achievement of specified accuracy, precision, and stability is only possible if the environmental constraints of temperature, relative humidity, and main supply voltage regulation are closely adhered to. Fluke clearly defines the environmental specifications for our calibrators and standards so you can match your instrumentation needs to the environment available in your facility.

Another consideration concerns metrology expertise. The lowest levels of calibration uncertainty are achieved in a primary level laboratory using high accuracy, extremely stable precision calibrators and standards. The metrology techniques required under these circumstances are extremely refined and sophisticated and demand either extreme expertise or an automated approach to compensate for the lack of that expertise. Fluke recognizes the importance of both manual and automated approaches to calibration and offers you tried and proven instrumentation solutions to match your unique situation.

## Literature Guide

To help you learn more about calibration, Fluke offers a wide variety of literature on various related subjects. Your Fluke Sales Engineer can provide you with brochures on specific products. And page of this catalog lists all technical literature available on applications and service products. Some specific items you may be interested are described below. Contact your Fluke Sales Engineer for copies.

**Calibration: Philosophy in Practice** is a 100-page book describing various aspects of calibration laboratory operation, types of calibration equipment, and the theories underlying them.

**A Fluke Equipped Traceable Lab** describes Fluke equipment used in primary and secondary laboratories. It includes traceability charts and definitions of terminology.

**Financial Analysis Information** (B0149) describes software available from Fluke for making financial analysis of Automated Calibration Workstations.

**Fluke Calibration: Building Confidence Into Your Every Measurement** describes how calibration fits into your everyday manufacturing environment. This brochure is specially targeted towards those who are not familiar with calibration.

**Dialog: The 5100 Series Calibrators** (B000) uses a question and answer format to develop your understanding of the 5100 in a logical manner.

**Dialog: 5440A/732A/752A Precision Direct Voltage Calibration System** (B0152) describes operating the 5440A Calibrator, 732A Standard, and 752A Divider as a system, using the same question and answer format. **Calibration Dialog** brochures are also available for the **7405A** (B0088) Automated Calibration Workstation and the **7410A** (B0137) Automated Calibration Workstation. "Calibrator Brings Record Accuracy Even to Production and Repair" is a reprint from *Electronics* magazine (September 8, 1982, page 121) describing how the 5440A and 732A and 752A are used as a system to bring precision voltage calibration out of the lab environment.

**IEEE-488-1978 Digital Interface for Programmable Instrumentation** (AB-36) explains the benefits and uses of interfacing test equipment via the IEEE-488 interface.

**Additional 7105A Calibration Techniques** (B0141) describes a method for upgrading a 7105A Calibration System using a 732A Standard and 752A Divider.

**Guarding of DVMs, Thermometers, and Calibrators** (AB-20) describes circuits and connections for guard terminals in calibration set-ups.

Amplifiers can be used with your calibrator to extend the direct and alternating voltage sourcing and current sourcing beyond the basic built-in capabilities of the calibrator. Amplifiers are controlled either from the calibrator's front panel or, in remote control and system applications, via the calibrator's IEEE-488 interface.

Fluke offers two Precision Power Amplifiers, the 5205A and 5215A, and one Transconductance Amplifier, the 5220A. Refer to the diagram below for information on which amplifiers are best suited to which Fluke calibrators.

### Amplifier Interfacing Guide

	5100B	5200A	5440B	5442A
5205A Precision Power Amplifier	(1)	●	●	—
5215A Precision Power Amplifier	(2)	●	X	X
5220A Transconductance Amplifier	●	—	●	—

● Programmable from source

— May be manually interconnected

X Not suitable for interconnection

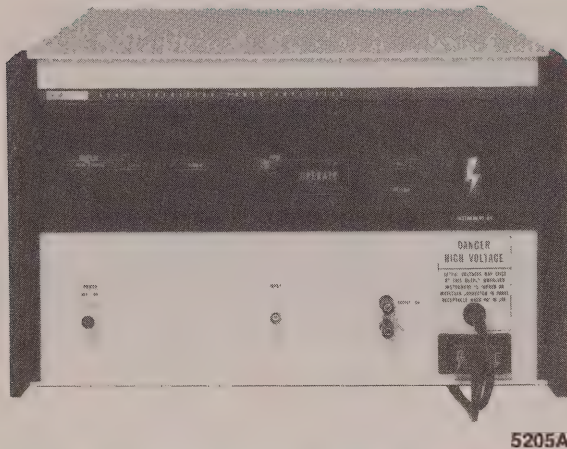
(1) With Y5000 and cable

(2) With Y5000 and cable but useable only for ac voltage mode



# AMPLIFIER

## 5205A



5205A

### 5205A Precision Power Amplifier

- Extends range of 5100 Series B, 5200A, 5440A, or 5440B calibrators
- Output voltages to 1100V rms,  $\pm 1500$ V dc
- Peak output power 220 watts
- DC to 100 kHz, typical upper limit 120 kHz
- 420 ppm midband amplitude uncertainty at 1000V rms
- 200 ppm midband six-month stability
- Fully programmable
- Short and overload protected

The 5205A Precision Power Amplifier is a dc coupled programmable inverting amplifier with a fixed gain of 100. Designed as a precision calibration amplifier, the 5205A is also useful as a general-purpose amplifier for a wide range of waveforms from dc to 100 kHz. Alternating voltage output level is specified to 1100V at up to 200 mA, with a typical upper limit of 1200V before automatically tripping into standby mode. Direct voltage output level is specified to  $\pm 1500$ V at up to 100 mA, with a typical upper trip limit of 1600V.

The 5205A includes automatic-overload sensing and recovery. Upon sensing an excessive slew rate or frequency of the input signal, or a momentary output overload, output is returned to zero within 2 microseconds and held there for 6 milliseconds or until the fault is corrected. When a steady overload, shorted output, or excessive input drive level is detected, the 5205A trips and locks into standby mode and displays a fault indicator.

A calibrator interface is standard, including an independent input signal line. When used with a 5100 Series B, 5200A, 5440A, or 5440B Calibrator, the 5205A is controlled by the calibrator as an extension of its capabilities.

A remote control interface is also standard, and independent of the calibrator interface. This allows remote switching between the calibrator and an alternate signal input source through a front panel BNC connector.

Amplifier features of the 5205A include a gain uncertainty of as little as 0.04%, and a slew rate as high as 800 volts per microsecond.

The 5205A includes a 1-meter output cable with a protective shrouded connector. When used with a 5200A AC Calibrator, remote sensing is brought to this connection point for maximum accuracy. An insulated receptacle is provided on the front panel for safe storage of the output connector when not in use. Option 5205A-07, for system applications, moves this cable and the BNC amplifier input connector to the rear panel.

All calibration adjustments and lamp replacements can be performed without exposure to high voltage. The output amplifier and all of the printed circuit modules are easily removed for repair or exchange.

### Calibration and Characterization

The 5205A is calibrated at the Fluke manufacturing facility by instrumentation traceable to the U.S. National Bureau of Standards. When ordered with a 5200A AC Calibrator, 5200A-900 characterization may be ordered including simultaneous characterization of the 5205A at points compatible with 5200A-800 software. See the 5200A Alternating Voltage Calibrator for more information.

### Specifications, Calibrator Mode

#### Calibrator Mode

##### Amplitude Uncertainty With 5100 Series B Calibrator

Absolute Uncertainty*	
Frequency Hz	$\pm(\text{ppm setting} + \text{mV})$
dc	700 + 20
50 - 10k	800 + 100
10 - 50k	1200 + 150

\* Traceable to U.S. NBS Standards. Includes transfer standards, dc reference source, and allowances for techniques. 180 days, 20°C to 30°C, after 1-hour warm-up

##### Amplitude Uncertainty With 5200A Calibrator

Basic Instrument Absolute Uncertainty*		Characterized Uncertainty**		
Frequency Hz	$\pm(\text{ppm setting} + \text{ppm range})$	Frequency Hz	$\pm(\text{ppm setting} + \text{ppm range})$	
			Relative	Absolute
10 - 30	1200 + 50	50 - 100	190 + 20	210 + 20
30 - 20k	400 + 20	100 - 10k	180 + 20	200 + 20
20k - 50k	800 + 50	10k - 20k	200 + 20	220 + 20
50k - 100k	1000 + 100	20k - 50k	310 + 30	630 + 30

\* Traceable to U.S. NBS Standards. Includes transfer standards, dc reference source, and allowances for techniques. 90 days, 18°C to 28°C, after 1-hour warm-up

\*\* 180 days, 18°C to 28°C, after 1-hour warm-up. Requires 5200A-900

##### Characterized-Point Absolute Uncertainty With 5200A: $\pm \text{ppm}$

Frequency, Hz							
50	100	200	1k	2k	10k	20k	50k
180	180	180	180	180	180	200	610

\* Traceable to U.S. NBS Standards. Includes transfer standards, dc reference source, and allowances for techniques. 180 days, 18°C to 28°C, after 1-hour warm-up. Requires 5200A-900

**Amplitude Uncertainty With 5440A or 5440B Calibrator:** Use amplifier-mode gain uncertainty specifications

**Output Voltage Range:** 100V to 1099.999V,  $\pm \text{dc}$  or rms ac

**Output Voltage Resolution:** 1 mV with 5200A, 5440A, or 5440B; 10 mV with 5100 Series B

**Temperature Coefficient:** For 0°C to 18°C and 28°C to 50°C, add  $\pm(0.025 \times \text{uncertainty})$  per °C below 18°C or above 28°C

**Stability With 5100 Series B, 5440A, or 5440B Calibrator:** Use amplifier-mode gain stability specifications

##### Stability With 5200A Calibrator

Frequency Hz	10 Minutes	24 Hours	6 Months
	$\pm(\text{ppm setting} + \text{ppm range})$		
10 - 100	0 + 50	100 + 0	200 + 0
100 - 20k	70 + 5	100 + 0	200 + 0
20k - 100k	70 + 5	200 + 0	400 + 0

\* Constant line, load, and temperature, total peak to peak random change in rms value

### Specifications, Amplifier Mode

Maximum Output Voltage: 1100V rms ac,  $\pm 1500$ V dc  
 Typical Overload Trip Voltage: 1200V rms ac,  $\pm 1600$ V dc  
 Maximum Input Voltage: 50V, dc or rms ac (without damage)  
 Frequency Range: dc to 100 kHz  
 Typical Upper Trip Frequency: 120 kHz  
 Gain: X100, inverting

#### Gain Uncertainty

Maximum Load	DC to 20 kHz	20 kHz to 100 kHz
500 $\Omega$ /100 pF	$\pm 0.05\%$	$\pm 0.2\%$
5000 $\Omega$ /100 pF	$\pm 0.05\%^*$	$\pm 0.15\%$
1 M $\Omega$ /200 pF	$\pm 0.05\%$	$\pm 0.2\%$
1 M $\Omega$ /500 pF	$\pm 0.06\%$	$\pm 0.4\%$
1 M $\Omega$ /1000 pF	$\pm 0.08\%$	$\pm 0.8\%$
1 M $\Omega$ /1500 pF	$\pm 0.1\%$	$\pm 1.2\%$

\* $\pm 0.04\%$ , dc to 10 kHz

Temperature Coefficient: For 0°C to 18°C and 28°C to 50°C, add per °C below 18°C or above 28°C: dc to 20 kHz:  $\pm(0.03 \times \text{uncertainty})$ ; 20 kHz to 100 kHz:  $\pm(0.06 \times \text{uncertainty})$

#### Gain Stability

Frequency Range	Max Capacitive Load	24 Hours	6 Months
dc to 20 kHz	1500 pF	0.03%	0.06%
20 kHz to 100 kHz	100 pF	0.08%	0.2%
20 kHz to 100 kHz	1500 pF	0.4%	0.8%

#### Maximum Slew Rates:\*

Maximum Load	Maximum Input Slew Rates	Maximum Output Slew Rates
200 mA Resistive	8.0V $\mu$ s	800V $\mu$ s
100 pF Capacitive	8.0V $\mu$ s	800V $\mu$ s
200 pF Capacitive	5.0V $\mu$ s	500V $\mu$ s
500 pF Capacitive	3.0V $\mu$ s	300V $\mu$ s
1000 pF Capacitive	2.0V $\mu$ s	200V $\mu$ s

\* Greater than 1000V output swing. Higher rates may trigger protection circuitry.

Maximum Output Overshoot: Less than 4% of amplitude, with less than maximum input slew rate, and with greater than 1000V output swing

Maximum Isolation Voltage: Output common may be floated up to  $\pm 10$ V dc or rms ac from chassis to reduce common mode errors

Input Impedance: 10 k $\Omega$  in parallel with less than 120 pF

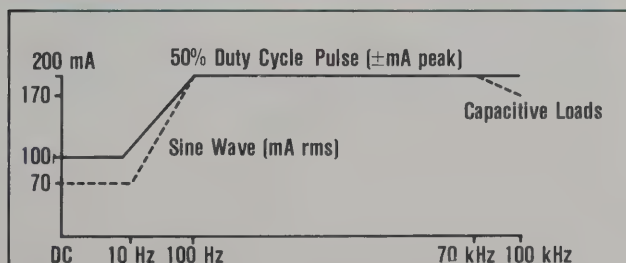
Input Connector: BNC, located on front panel. (Located on rear panel with Option -07)

Maximum Input Voltage: 50V dc or rms ac

Maximum Input Bias Current: 100 nA

### General Specifications

Maximum Load Current: Bipolar Symmetrical Waveform



Unipolar Rectangular Waveform:  $\pm 200$  mA peak. Pulse width less than 5 msec; period greater than 10 msec. Linearly Derating To:  $\pm 100$  mA peak. Pulse width greater than 50 msec; period less than 100 msec

\* Referenced to zero volts. Under all circumstances, output current capability is at least  $\pm 100$  mA peak

Maximum Capacitive Load: 1500 pF, not to exceed rated load current. (Example: maximum capacitive load at 1000V, 100 kHz is 270 pF)

DC Offset Voltage:  $\pm 10$  mV at the output\*

\*90 days, 18°C to 28°C, after 1-hour warm-up

Total Harmonic Distortion: Resistive loads greater than 1500 $\Omega$  or capacitive loads less than 1000 pF

10 Hz to 20 kHz	0.05% of setting
20 kHz to 50 kHz	0.07% of setting
50 kHz to 100 kHz	0.1% of setting

Resistive loads less than 1500 $\Omega$  or capacitive loads greater than 1000 pF

10 Hz to 10 kHz	0.05% of setting
10 kHz to 20 kHz	0.1% of setting
20 kHz to 50 kHz	0.17% of setting
50 kHz to 100 kHz	0.25% of setting

\*Bandwidth 10 Hz to 1 MHz

Overload Protection: Limit protection against input noise spikes, momentary output overloads, excessive input slew rate, and excessive input frequency. Trip protection against input overdrive, steady overloads, and short circuit.

Random Noise: Less than 100 mV rms, 1 MHz bandwidth

Line-Related Noise: Less than 50 mV rms

Line Regulation:  $\pm 10$  ppm of setting for 10% change in line voltage

Input Power: 100V, 115V, 200V, 230V ac,  $\pm 10\%$ , internal jumper selected, 50 Hz to 60 Hz, 1800 VA at full load. Receptacle on rear panel for calibrator power

Size: 26.7 cm H x 43.2 cm W x 62.7 cm D (10.5 in H x 17 in W x 24.7 in D)

Weight: 54.5 kg (120 lb)

Included: Instruction Manual, interface cable to 5200A

### Model

January 1985 prices

5205A Precision Power Amplifier ..... \$8950

### Option

5205A-07 Rear Input/Output ..... 20

### Accessories (Also see page 230)

Y5000 Interface Buffer for 5100 Series	535
Y5001 Interface Cable for 5100 Series, 5440A, or 5440B	240
M10-205-600 Rack Mount Kit for 5205A	105
M00-280-610 24" Rack Slides for rack adapter	110

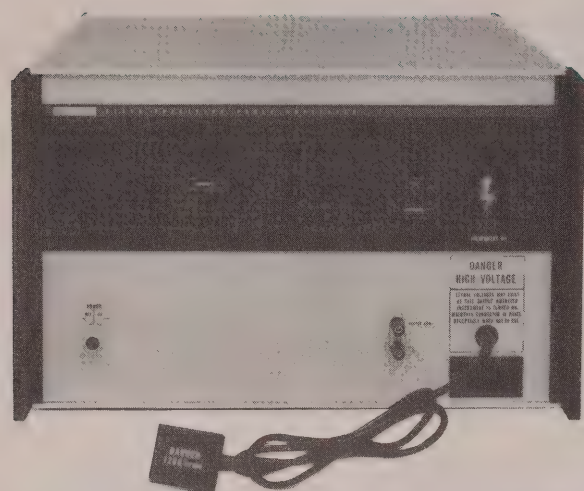
### After-Warranty Service (See page 227)

SC1-5205A, per 90-day interval ..... 760



# AMPLIFIER

5215A



5215A

## 5215A Precision Power Amplifier

- Designed for the 5200A AC Calibrator
- Output voltages to 1100V rms
- Peak output power 220 watts
- 10 Hz to 100 kHz, typical upper limit 120 kHz
- 420 ppm midband amplitude uncertainty at 1000V rms
- 200 ppm midband six-month stability
- Fully programmable
- Short and overload protected

The 5215A Precision Power Amplifier is an ac coupled programmable inverting amplifier with a fixed gain of 100. AC output level is specified to 1100V at up to 200 mA, with a typical upper limit of 1200V before automatically tripping into standby mode.

The 5215A includes automatic-overload sensing and recovery. Upon sensing an excessive slew rate or frequency of the input signal, or a momentary output overload, output is returned to zero within 2 microseconds and held there for 6 milliseconds or until the fault is corrected. When a steady overload, shorted output, or excessive input drive level is detected, the 5215A trips and locks into standby mode and displays a fault indicator.

An interface for a Model 5200A AC Calibrator is standard, allowing the 5215A to be controlled by the calibrator as an extension of its capabilities.

The 5215A includes a 1-meter output cable with a protective shrouded connector. Remote sensing is brought to this connection point for maximum accuracy. An insulated receptacle is provided on the front panel for safe storage of the output connector when not in use. Option 5215A-07, for system applications, moves this cable to the rear panel.

All calibration adjustments and lamp replacements can be performed without exposure to high voltage. The output amplifier and all of the printed circuit modules are easily removed for repair or exchange.

## Calibration and Characterization

The 5215A is calibrated at the Fluke manufacturing facility by instrumentation traceable to the U.S. National Bureau of Standards. When ordered with a 5200A AC Calibrator, 5200A-900 characterization may be ordered including simultaneous characterization of the 5215A at points compatible with 5200A-800 software. See the 5200A Alternating Voltage Calibrator for more information.

## Specifications

### Amplitude Uncertainty

Basic Instrument Absolute Uncertainty*		Characterized Uncertainty**		
Frequency Hz	$\pm(\text{ppm setting} + \text{ppm range})$	Frequency Hz	$\pm(\text{ppm setting} + \text{ppm range})$	
			Relative	Absolute
10 - 30	1200 + 50	50 - 100	190 + 20	210 + 20
30 - 20k	400 + 20	100 - 10k	180 + 20	200 + 20
20k - 50k	800 + 50	10k - 20k	200 + 20	220 + 20
50k - 100k	1000 + 100	20k - 50k	310 + 30	630 + 30

\* Traceable to U.S. NBS Standards. Includes transfer standards, dc reference source, and allowances for techniques. 90 days, 18°C to 28°C, after 1-hour warm-up

\*\* 180 days, 18°C to 28°C, after 1-hour warm-up. Requires 5200A-900

### Characterized-Point Absolute Uncertainty: $\pm$ ppm

Frequency, Hz							
50	100	200	1k	2k	10k	20k	50k
180	180	180	180	180	180	200	610

\* Traceable to U.S. NBS Standards. Includes transfer standards, dc reference source, and allowances for techniques. 180 days, 18°C to 28°C, after 1-hour warm-up. Requires 5200A-900

**Output Voltage Range:** 100V to 1099.999V,  $\pm$ dc or rms ac

**Output Voltage Resolution:** 1 mV with 5200A or 5440B; 10 mV with 5100 Series

**Temperature Coefficient:** For 0°C to 18°C and 28°C to 50°C, add  $\pm(0.025 \times \text{uncertainty})$  per °C below 18°C or above 28°C

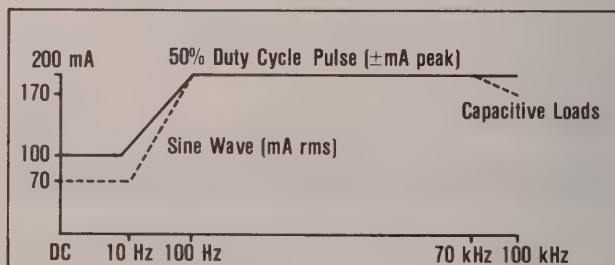
### Stability

Frequency Hz	10 Minutes	24 Hours	6 Months
	$\pm(\text{ppm setting} + \text{ppm range})$		
10 - 100	0 + 50	100 + 0	200 + 0
100 - 20k	70 + 5	100 + 0	200 + 0
20k - 100k	70 + 5	200 + 0	400 + 0

\* Constant line, load, and temperature, total peak to peak random change in rms value

**Maximum Isolation Voltage:** Output common may be floated up to  $\pm 10$ V dc or rms ac from chassis to reduce common mode errors

**Maximum Load Current:**



**Maximum Capacitive Load:** 1500 pF, not to exceed rated load current. (Example: maximum capacitive load at 1000V, 100 kHz is 270 pF)

**DC Offset Voltage:**  $\pm 10$  mV at the output\*

\*90 days, 18°C to 28°C, after 1-hour warm-up

## AMPLIFIER

5215A

**Total Harmonic Distortion:**\* Resistive loads greater than 1500 $\Omega$  or capacitive loads less than 1000 pF:

10 Hz to 20 kHz	0.05% of setting
20 kHz to 50 kHz	0.07% of setting
50 kHz to 100 kHz	0.1% of setting

Resistive loads less than 1500 $\Omega$  or capacitive loads greater than 1000 pF:

10 Hz to 10 kHz	0.05% of setting
10 kHz to 20 kHz	0.1% of setting
20 kHz to 50 kHz	0.17% of setting
50 kHz to 100 kHz	0.25% of setting

\*Bandwidth 10 Hz to 1 MHz

**Overload Protection:** Limit protection against input noise spikes, momentary output overloads, excessive input slew rate, and excessive input frequency. Trip protection against input overdrive, steady overloads, and short circuit

**Random Noise:** Less than 50 mV rms

**Line Regulation:**  $\pm 10$  ppm of setting for 10% change in line voltage

**Input Power:** 100V, 115V, 200V, 230V ac,  $\pm 10\%$ , internal jumper selected, 50 Hz to 60 Hz, 1800 VA at full load. Receptacle on rear panel for calibrator power

**Size:** 26.7 cm H x 43.2 cm W x 62.7 cm D (10.5 in H x 17 in W x 25 in D)

**Weight:** 54.5 kg (120 lb)

**Included:** Instruction Manual, interface cable for 5200A

## Model

January 1985 prices

5215A Precision Power Amplifier ..... \$8290

## Option

5215A-07 Rear Only Output ..... 20

## Accessories (Also see page 230)

Y5001 Interface Cable for 5100 Series, 5440A, or 5440B .... 240

M10-205-600 Rack Mount Kit for 5205A ..... 105

M00-280-610 24" Rack Slides for rack adapter ..... 110

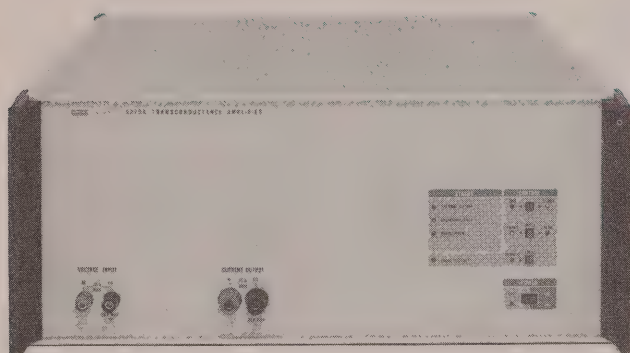
## After-Warranty Service (See page 227)

SC1-5215A, per 90-day interval ..... 768



# AMPLIFIER

## 5220A


**5220A**

### 5220A Transconductance Amplifier

- 20 amps output dc or rms ac
- 0.025% basic dc accuracy
- Over-voltage and over-current protection
- Over-temperature protection
- May be programmed through the 5100B Series B

The Model 5220A Transconductance Amplifier lets you calibrate ac or dc current meters and shunts and the current functions of digital multimeters and VOMs that measure up to 20 amperes. A known input voltage of 1 to 20 volts produces a known output current of 1 to 20 amperes. The transconductance is 1 ampere per volt, either dc or rms ac from 30 Hz to 5 kHz.

The 5220A is designed to be controlled by the 5100B or 5101B Calibrator but may be driven by another voltage source such as the 5200A. When used with a 5100B or 5101B, the current range of those instruments is extended by a factor of 10 to 1. Also, options are available for the 5100B and 5101B that make the system compatible with IEEE Std 488-1978 or EIA Standard RS-232-C. A built-in mag cassette tape for the 5101B can be used to record the calibration steps of each procedure then later can be used to repeat the procedure with very little operator expertise.

### Built-in Protection

The 5220A is built to survive in the "real" world of practical, day-to-day use. Protection is designed in to eliminate problems caused by excessive inputs, open inputs, and overcompliance. Indicators on the front panel tell the user about any of these conditions. Automatic shut down occurs should the internal temperature rise excessively.

### The Y5000 Interface/Buffer

Drive voltage to the 5220A may be introduced through the front panel or the rear panel. The connector on the rear, however, allows the 5220A to work with a 5100B (or 5101B) Calibrator through an Interface/Buffer (Y5000) and cable that attaches to the rear panels.

With the Y5000 Interface/Buffer, the two instruments operate as one integrated calibration system with all the advantages of single-control-point calibration: automatic error calculation, entry limit protection, etc.

A single Y5000 Interface/Buffer may be used to control and operate both a 5220A Transconductance Amplifier and a 5205A Power Amplifier from a 5101B (or 5100B).

### Specifications

The specifications below apply for 180 days for instruments operated between 20°C and 30°C in a relative humidity of 70% or less.

**Transconductance:** 1 siemens (1 ampere per volt)

**Output Range:** 0 to 20A dc or rms ac (28.3A peak)

**Maximum Compliance Voltage:**  $\geq \pm 4V$  dc, or 3V rms ac (4.25V peak)

**DC Accuracy:**  $\pm(0.025\%$  of output +1 mA)

**AC Accuracy:**  $\pm(0.05\%$  of output +1 mA) from 30 Hz to 1 kHz, and  $\pm(0.05\%$  of output +1 mA)  $\times f$  from 1 kHz to 5 kHz, where  $f$  = frequency in kHz

**Short Term DC Stability:** Output changes less than  $\pm(0.005\% + 200 \mu A)$  in 10 minutes, with constant line, load, and temperature

**Short Term AC Stability:** Output changes less than  $\pm(0.01\% + 500 \mu A)$  in 10 minutes, with constant line, load, and temperature

**Harmonic Distortion and Noise:**  $\pm(0.05\%$  of output  $\pm 1$  mA) over frequency range of 30 Hz to 1 kHz and measured with a noise bandwidth of 300 kHz,  $\pm 0.05\%$  of output +1 mA  $\times f$  from 1 kHz to 5 kHz, where  $f$  = frequency in kHz

**Temperature Coefficient:**  $\pm(0.0025\%$  of output +100  $\mu A$ ) per degree C, above 30°C or below 20°C

**Transient Recovery:** Output will settle to within 0.01% of final value within 2 seconds following a programmed change in output current or frequency (10 ms for 5220A alone)

**Load Capability:** Drives all resistive and capacitive loads consistent with current and compliance voltage capability. Drives inductive loads (with reduced accuracy) up to 200 microhenries, consistent with current and compliance voltage capability

**Maximum Isolation Voltage:**  $\pm 20V$  dc or 20V ac rms

**Temperature Range:** 0°C to 50°C (operating) and -20°C to 65°C non-operating

**Relative Humidity:**  $\leq 50\%$  to 50°C,  $\leq 75\%$  to 40°C,  $\leq 95\%$  to 25°C

**Altitude:** 0 to 10,000 feet (operating) and 0 to 40,000 feet (non-operating)

**Vibration:** 2G maximum, 5 Hz to 55 Hz for 15 minutes

**Shock:** 15G maximum, half sinewaves

**Power:** 100, 110, 115, 120, 200, 220, 230, or 240V ac  $\pm 10\%$ , switch-selectable, 50 Hz to 60 Hz, 300 watts

**Size:** 17.8 cm H  $\times$  43.2 cm W  $\times$  55.9 cm D (7 in H  $\times$  17 in W  $\times$  22 in D), case only

**Weight:** 227 kg (50 lb)

**Included:** Manual, power cord

### Model

January 1985 prices

5220A Transconductance Amplifier ..... \$4300

### Accessories (Also see page 230)

Y5020 Current Shunt .....	670
Y5000* Interface/Buffer .....	535
Y5002* Cable (Y5000 to 5220A) .....	215
M07-205-600 7" Rack Adapter .....	100
M00-260-610 18" Slides for Rack Adapter .....	105
M00-280-610 24" Slides for Rack Adapter .....	110

\*Required when controlled from 5100B or 5101B

### After-Warranty Service (See page 227)

SC1-5220A, per 90-day interval .....	220
SC1-Y5020, per 90-day interval .....	48



Y5020

### Y5020 AC or DC Current Shunt

- Rated to 20A dc to 5 kHz
- 100 ppm uncertainty
- 10 milliohms nominal resistance
- Less than 250 mV burden

The Y5020 Current Shunt is a very stable, non-inductive, four-terminal resistive current shunt. It may be used to verify the accuracy of the 5220A Transconductance Amplifier or other current calibrators. It is an inexpensive method of accurately measuring current up to 20 amperes, from dc to 5 kHz. The 0.01Ω nominal resistance creates less than 250 mV burden. A forced-air cooling fan stabilizes internal ambient temperature during use.

### Specifications

The following specifications apply for one year, provided the Y5020 is operated with its cooling fan in ambient temperatures from 18°C to 28°C. Voltage terminals must be connected to a measurement circuit with an input resistance of 1 MΩ or greater and a capacitance of 500 pf or less.

**Nominal Resistance:** 0.01Ω ±1%

**Uncertainty:**\* Direct current, ±100 ppm; alternating current, ±(150 ppm + 120 ppm x frequency in kHz) relative to direct current specification

\* Referenced to the certified absolute value of shunt resistance stamped on the front panel

**Stability:** Less than 20 ppm resistance change in six months

**Maximum Current:** 20A direct current or rms alternating current

**Burden Voltage:** Less than 250 mV at 20 Amperes

**Temperature Coefficient:** Less than 20 ppm/°C; 18°C to 0°C and 28°C to 50°C

**Power Coefficient:** Less than 12 ppm per watt

**Operating Temperature:** 0°C to 50°C ambient

**Storage Temperature:** -40°C to 70°C

**Input Power:**\* 115V or 230V ac ±10%, 11 watts

**Size:** 12.7 cm H x 20.5 cm W x 3.6 cm D (5.0 in H x 8.0 in W x 12.9 in D)

\*For cooling fan. Specify 115V or 230V when ordering

### Model

January 1985 prices

Y5020\* Current Shunt ..... \$670

\*Specify supply voltage (e.g., Y5020-115 or Y5020-230)



# CALIBRATION PRODUCTS

## The Fluke Commitment to Calibration Leadership

The John Fluke Mfg. Co., Inc. is a major supplier of quality test and measurement instruments to the electronics industry. For 35 years Fluke has been a pioneer in providing state-of-the-art support for calibrations and standards laboratories. From dc calibrators to sophisticated multimeter calibration systems, Fluke has provided not only the finest instruments, but has also offered advanced laboratory standards, customer training, and conscientious after-sales support through an international network of service centers. Customers rely on Fluke products for dc and low frequency ac calibration because of Fluke's leadership in cost-effective performance, reliable specifications, and dependability.

Fluke is serious about calibration. You will find that Fluke products not only offer higher performance and more value, but fully satisfy your needs for traceable support equipment, training, and service. Among the over 100 calibration products Fluke offers, a consistent characteristic has been technological leadership at the time of introduction. Others have followed Fluke's technological lead, but none can match Fluke's commitment to providing innovative calibration products and dedication to customer service and support both before and after the point of sale.

Fluke is committed to responding to your calibration needs.

## Why Calibrate?

Calibration makes it possible to achieve accuracy, precision, and interchangeability. That enables science and technology, along with engineering and mass-production techniques, to make our world what it is today. Coupled with metrology, the "science of measurement," calibration is the foundation of our confidence in the electrical and electronic test and measurement instruments we use daily. If you are affected by government regulation such as, in the United States, MIL-STD-45662, NRC 10CFR50 Appendix B, or the Federal Food, Drug, and Cosmetic Act, then you are especially concerned with "calibration system requirements" and "traceability to the National Bureau of Standards."

## Fluke and Calibration

Fluke responds to the demand for traceability by having a meticulous metrology system. The system gives assurance that all measurement standards and instruments used in the manufacture of our products, as well as the primary reference standards used by Fluke Technical Service Centers for calibration services are all calibrated and certified as traceable to the U.S. National Bureau of Standards.

Fluke has over thirty years experience manufacturing the calibrators and standards that provide you with the all-important measurement confidence you must have. Certified traceability to the NBS is available to you for all our products.

## Calibration Seminars

Fluke regularly presents seminars, "Calibration: Philosophy in Practice." This one-day seminar covers such topics as calibration terminology, history, traceability, standards, ac and dc calibration, and automated calibration. You will also receive hands-on experience on the newest Fluke calibration equipment. Contact your local Fluke Sales Office or Technical Service Center and reserve your place in the next seminar in your area.

### Local Primary Standards

Local primary direct voltage and resistance standards serve as the foundation for both dc and low frequency calibration. The accuracy of these standards is ensured by periodically submitting them to the National Bureau of Standards for comparison with their working standards. Temperature controlled saturated standard cells, four-terminal standard resistors (of the Thomas or NBS-type), and standard dividers provide calibration laboratories with the standards of voltage, resistance, and ratio they need. With them, accurate transfer of certified values may be made to calibrators, portable solid-state reference standards, and lower-echelon working standards and transfer standards. From these two local primary standards, voltages and resistances at other levels can be defined. Together, they define direct and alternating current.

### Direct Voltage Reference Standards

Portable, solid-state dV reference standards, such as the Fluke 732A and 731B are designed to provide metrology laboratories, engineering areas and production test groups with a working standard of direct voltage that can be used in calibration, research and development. These standards provide the stability of standard cells without the problems associated with standard cells — such as intolerance to loading, vibration, and ambient temperature variations. There is an added advantage to working with a 10-volt reference instead of a 1-volt reference: Effects of noise and thermal emf are greatly reduced. The self-contained battery power supply and temperature-controlled oven of the 732A make this instrument suitable for the most exacting requirements of a precision transfer standard.

### Alternating Voltage Calibration

Calibration of aV instrumentation is especially complicated by the fact that there are no reproducible standards of alternating voltage. Since there is no aV counterpart to the standard cell, alternating voltages and currents must first be either rectified and converted to dV or compared to the heating effect of an equivalent direct voltage or current which may then be referred to an appropriate dV standard. A complication of the comparison process is knowing the frequency response of the converter. Fluke has, for many years, provided both aV and dV standards as well as the thermal transfer standards needed for comparing the aV standards to the dV standards.

### Thermal Transfer Standards

Thermal transfer standards may be used to accurately measure an unknown alternating voltage or current by comparing the heating effect of the unknown with the heating effect of an equivalent direct voltage or current which is known. The Fluke 540B Thermal Transfer Standard provides the capability in an instrument designed for simple operation and wide dynamic range. For voltage measurements at frequencies above the 1 MHz range of the 540B, the A55 High Frequency Thermal Converters may be added to extend the range to 50 MHz. Alternating current measurement capability may also be added by means of the A40 and A40A shunts.

### Alternating Voltage Reference Standards

Fluke responded to the need for a precision fixed-frequency sinewave voltage source suited to calibration or reference applications with its 510A AC Reference Standard. In the calibration laboratory or out on the production floor, the Fluke 510A offers portability and an accurate 10V output available at any specified frequency from 50 Hz to 100 kHz. The 510A provides you with the ultimate in applications flexibility.

### Alternating Voltage Calibration System

Calibration of aV devices and instrumentation up to 1200V rms and frequencies up to 1.2 MHz is available using the Fluke 5200A Precision AC Calibrator and a 5205A Power Amplifier. Either an IEEE-488 interface or parallel interfacing is compatible. Fluke has designed this system to provide you with the option of either manual or semi-automated approaches to the calibration of aV voltmeters, DMMs, and other frequency-sensitive devices that require precision, variable frequency, and voltage stimuli.

#### DV Standards and Auxiliary Equipment

- 732A DV Reference Standard
- Direct Voltage Maintenance Program
- 731A DC Reference Standard
- 750A Reference Divider
- 752A Reference Divider
- 720A Kelvin-Varley Divider
- 721A Lead Compensator
- 845AB/AR Voltmeter/Null Detector

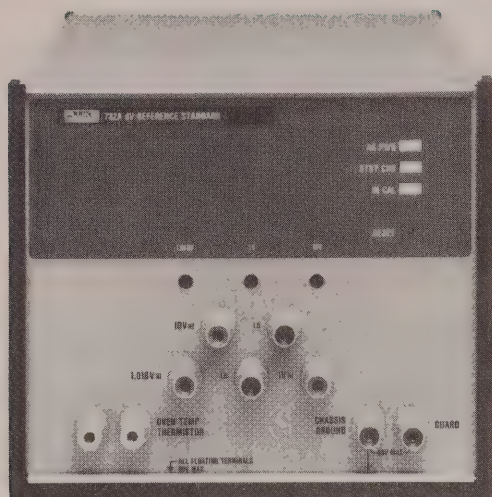
#### AV Standards and Auxiliary Equipment

- 510A AC Reference Standard
- 540B Thermal Transfer Standard
- A40/A40A Current Shunt
- A55 Thermal Converter



# STANDARDS & AUXILIARY EQUIPMENT

## 732A



732A

### 732A DC Reference Standard

- 10V, 1V and 1.018V outputs
- 0.5 ppm stability per month
- 18°C to 28°C operation at full accuracy specs
- Short circuit proof
- Traceable calibration available through Fluke Direct Voltage Maintenance Program to NBS
- Line and rechargeable battery powered
- 12-hour battery life for calibration transfer

The Fluke 732A is a solid state, dc voltage reference standard which provides significant performance improvements in stability, ruggedness, and transportability. Its 10V output offers better resolution, lower noise, and simpler operation than standard cells. The 732A also includes outputs of 1.0 and 1.018 volts.

The accuracy and stability of the 732A allows direct substitution for saturated standard cells in many applications. Its stability of 0.5 ppm for 30 days provides the confidence necessary to calibrate high-performance instruments. In addition, the use of the 10V output as a primary reference standard means that the effects of thermal emfs and noise are reduced.

The 732A can be shorted, even for extended periods of time, without damage and recovers without loss of stability. The unit may be powered by line voltage or will operate 12 hours on its internal battery — even longer on external batteries. Either line power or the battery may be removed without affecting the output.

Saturated standard cells are fragile and susceptible to shock and vibration during traveling. The 732A was designed for air or ground shipment with no special handling.

The internal oven has high thermal gain allowing full accuracy to be specified over an operating range of 23°C  $\pm$  5°C. Therefore, this new reference standard may be used outside of the conventional standards laboratory environment in areas where saturated cells or other transfer standards would not be reliable.

The 732A DC Reference Standard was originally developed by Fluke to transfer "the volt" into our own manufacturing facility. The unprecedented success achieved by this effort led to the development of the 732A for the commercial market. Fluke has developed a worldwide network of regional support centers to provide calibration support for the 732A where local standards are not available. These centers maintain volt-transfer programs with the national standards laboratories.

### Specifications\*

These specifications include effects of line voltage variations of  $\pm$ 10% and assume the 732A has been continuously powered.

**Stability:** Parts per million, 18°C to 28°C

Output	30 Days	90 Days	6 Months	1 Year
10V	$\pm$ 0.5	$\pm$ 1.5	$\pm$ 3.0	$\pm$ 6.0
1.018V	$\pm$ 1.5	$\pm$ 4.0	$\pm$ 6.0	$\pm$ 12.0
1V	$\pm$ 1.5	$\pm$ 4.0	$\pm$ 6.0	$\pm$ 12.0

**Temperature Coefficient:**  $\pm$ 0.05 ppm per °C for 10V range,  $\pm$ 1.0 ppm per °C for 1V and 1.018V ranges, from 18°C to 0°C or 28°C to 40°C

**Output Adjustment:**  $\pm$ 50  $\mu$ V for 10V and 1.018V ranges,  $\pm$ 5  $\mu$ V for 1.0V range

**Output Impedance:**  $\leq$ 5 m $\Omega$  for 10V output, 1 k $\Omega$  for 1V and 1.018V outputs

**Output Current:**  $\leq$ 12 mA at 10V output. Limited by 1 k $\Omega$  output impedance at 1V and 1.018V output

**Output Protection:** May be shorted indefinitely. Protected against high voltage input transients to 1100V

**Load Regulation:**  $\leq$ 6 ppm at 10V output from 0 to 12 mA

**Line Regulation:**  $\leq$ 0.05 ppm of output for  $\pm$ 10% line change

**Output Noise:**  $\leq$ 1  $\mu$ V rms at 10V output from 0.1 Hz to 10 Hz

\*See the Direct Voltage Maintenance Program description on page 121 for the improved specifications and traceability which can be obtained for the 732A.

### General Specifications

**Temperature:** 0°C to 40°C, operating; 0°C to 50°C, non-operating (with internal battery pack switched off)

**Relative Humidity:**  $\leq$ 95% to 30°C,  $\leq$ 75% to 40°C, non-condensing

**Altitude:**  $\leq$ 3050m (10,000 ft) operating

**Vibration:** Per MIL-T-28800, Type III, Class 5, Style E

**Safety:** IEC 348, 2nd edition, 1978 and ANSI C39.5, 1980

**Power:** 100V, 120V, 220V, or 240V ac  $\pm$ 10%, 50 to 400 Hz or 24 to 30V ac 50 to 60 Hz. Also external 24 to 40V dc. Internal 24-V lead acid, gelled electrolyte battery operates for 12 hours at 23°C when fully charged. Trickle-charged continually when external power is applied

**Size:** 19.1 cm H x 22.1 cm W x 60.3 cm D (7.53 in x 8.69 in x 23.75 in)

**Weight:** 12.3 kg (27 lb)

**Included:** Instruction manual, line cord, adjustment tool

### Model

January 1985 prices

732A DC Reference Standard ..... \$2995

### Accessories (Also see page 230)

732A-7001 Replacement Battery Pack ..... 330

732A-7002 Transit Case ..... 430

5440A-7003 Low Thermal Cables ..... 315

### After-Warranty Service (See page 227)

SC1-732A, per 90-day interval ..... 148

# STANDARDS & AUXILIARY EQUIPMENT

## Direct Voltage Maintenance Program

### Direct Voltage Maintenance Program

- Volt traceability for your calibration laboratory with significant cost reductions over direct NBS calibration
- Uncertainty within a few tenths of a ppm
- Complies with MIL-STD-45662
- Avoid investing in redundant hardware: your equipment never needs to leave your laboratory
- No possibility of accidental loading and destruction as with saturated standard cells

Built around the 732A Direct Voltage Reference Standard, the Fluke Direct Voltage Maintenance Program (DVMP) provides state-of-the-art uncertainty for your own laboratory, traceable to the U.S. National Bureau of Standards (NBS). The 732A is a solid-state direct voltage reference standard which enables voltage transfers with uncertainties of only a few tenths of a ppm, while meeting the requirements for ruggedness and a range of operating temperatures. This level of performance is made possible by the low, predictable drift rate, allowing accurate extrapolation of the output voltage to be made over long time intervals. With the DVMP, dissemination of the legal volt can be easily accomplished around the world with an uncertainty of less than one ppm.

### Traceability

Traceability to the legal volt is the principle objective of the DVMP. The Fluke Primary Standards Laboratory in Everett, Washington (U.S.A.) maintains traceability to NBS and other national standards laboratories at the 10 volt level. Fluke establishes a "Traceability Plane" for you consisting of the mean (average) of the reference voltages maintained by participating laboratories.

### Six Services to Choose From

The Fluke Direct Voltage Maintenance Program consists of six services which can be used separately or in combination, depending on your needs:

1. **Option 732A-000**, Output voltage calibration of the 732A prior to delivery and shipment under power. You receive a 732A which has been compared to the direct voltage standards maintained in the Fluke Primary Standards Laboratory. A certificate of calibration listing the deviation from the nominal and the uncertainty of calibration is delivered with the instrument.
2. **Option 732A-000R**, Output voltage calibration of a 732A purchased earlier and returned to Fluke for re-calibration. This is the same service as for Option 732A-000, but performed on an instrument purchased previously.
3. **Option 732A-100**, Output voltage calibration and drift rate certification of the 732A prior to delivery and shipment of the instrument under power. You receive a 732A which has been calibrated and certified for both output voltage and drift rate. The drift rate is determined during 60 days of testing in the Fluke Standards Laboratory prior to shipment. Knowing the drift rate, the total uncertainty as a function of time is much reduced. A certificate of calibration listing deviation from the nominal, drift rate, and uncertainties is delivered with the instrument.
4. **Option 732A-100R**, Output voltage and drift rate calibration of a 732A purchased earlier and returned to Fluke for re-calibration. Same service as for Option 732A-100 but performed on an instrument purchased previously.
5. **Option 732A-200**, Certification of your 10 volt reference on-site. A certified Fluke-owned 732A is sent under power to your site for comparison with your reference standard. A series of readings made over a period of five days is recorded and then evaluated at the Fluke Primary Standards Laboratory. A value is then assigned

to your 10 volt standard relative to the legal volt, and relative to the mean volt as maintained by the additional laboratories participating in the DVMP.

6. **Option 732A-201**, Certification of additional references on same site (must be ordered with Option 732A-200). This service used with Option 732A-200 will provide for the certification of additional references at the same facility when no added shipping is involved.

### Specifications

Option Number	Calibration Uncertainty (CU)*	Drift Rate Uncertainty (DU)**			Total Uncertainty
		30 Days	90 Days	1 Year	
732A-000	0.6 ppm	0.5 ppm	1.5 ppm	6.0 ppm	[(CU) <sup>2</sup> + (DU) <sup>2</sup> ] <sup>1/2</sup>
732A-100	0.6 ppm	0.35 ppm	0.5 ppm	1.5 ppm	
732A-200	0.6 ppm	**	**	**	

\* Typical 99% confidence level; actual uncertainties determined at the time of test

\*\* Drift rate uncertainty will be established with repeated participation in the DVMP

### How To Order

It is important to recognize that proper timing and coordination of the activities between Fluke and your firm are essential to successful delivery of a 732A under power. Following receipt of an order for one of the DVMP services, you will be contacted directly by Fluke factory personnel. For this reason the following information must be included with each order:

- The option number ordered.
- If options 732A-000R or 732A-100R are ordered, include the serial number of the instrument to be returned to Fluke for the service.
- The exact address where the shipment will be received.
- The name and telephone number of the person who will be responsible for receiving the shipment and connecting it to the power line when it arrives.
- The name and telephone number of an alternate responsible person if the first designated individual is unavailable.
- Any restrictions on hours of the day during which receiving can take place.
- Fluke guarantees arrival of the instrument under power. If it is delayed, Fluke or the carrier will pay the shipping charges for return of the instrument to Fluke for recalibration.

### Models

January 1985 prices

732A-000 Special Calibration, shipped hot	\$3245
732A-000R Special Calibration, shipped hot	250
732A-100 Calibration, Drift Certification, shipped hot	3495
732A-100R Calibration, Drift Certification, shipped hot	500
732A-200 On-Site 10V Certification w/Fluke Standard	350
732A-201 Certification of Additional Reference/Same Site	75



# STANDARDS & AUXILIARY EQUIPMENT

## 731B/750A



731B

### 731B DC Reference Standard

- Outputs at 10, 1, 1.018, and delta E
- 10 ppm output accuracy
- Guarded floating output up to 500V above ground
- Line and battery powered

The Fluke Model 731B DC Reference Standard is a versatile instrument providing stability, while utilizing the excellent performance capabilities of solid-state technology. The instrument furnishes a variety of precision voltages with switched output ranges including 1.0, 1.018+ΔE, 10.0, and ΔE volts. Delta E (ΔE) provides a variable output of 0 through 999 μV which is either added to the voltage of a standard cell transfer or may be used directly as a low-level, stable dc voltage source.

### Specifications

Output Ranges: 10V, 1V, 1.018 + ΔE, 1.019 + ΔE, ΔE  
Output Accuracy:\*

Range	30 Days	90 Days	1 Year
10V	±10 ppm	±15 ppm	±30 ppm
1V	±10 ppm	±15 ppm	±30 ppm
1.018 + ΔE	±10 ppm	±15 ppm	±30 ppm
1.019 + ΔE	±10 ppm	±15 ppm	±30 ppm
ΔE	—	—	±2 μV

\*Absolute accuracy at 23°C ±1°C after 30 minutes warm-up

### Transfer Accuracy (Stability)

Between	4 Hours
Standard cells on 1.018V + ΔE ranges or 1.019V + ΔE ranges	2 ppm
Standard cell and 1V output	3 ppm
10V output and standard cell or 1V output	5 ppm

Source Resistance: 10V range is <0.07Ω. The 1V, 1.018V, 1.019V, and ΔE Ranges are <1 kΩ

Output Protection: The output may be shorted indefinitely without damage to instrument

Line Regulation: <1 ppm for ±10% line voltage variation

Ripple & Noise: <1 ppm p-p dc to 1 Hz, <20 μV rms 1 Hz to 1 MHz, except <70 μV rms at 10V output

Common Mode Noise Rejection: ≥120 dB at dc, ≥100 dB at 60 Hz, ≥85 dB at 400 Hz

Isolation: Output may be floated up to 500V dc between chassis ground and guard

Temperature: 0°C to 55°C, operating

Power: 115V or 230V ac ±10V, 50 to 400 Hz or internal rechargeable batteries, 6W max, 120 mA max

Size: 8.8 cm H x 10.7 cm W x 30.4 cm D (3.5 in x 4.5 in x 12 in)

Weight: 2.26 kg (5 lb)

Included: Manual, power cord, batteries

### Model

January 1985 prices

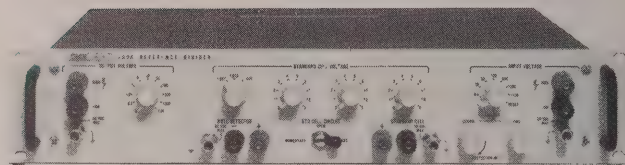
731B DC Reference Standard ..... \$1545

### Accessories (Also see page 230)

M03-201-601 3½" Rack Adapter, Single ..... 105  
M03-202-603 3½" Rack Adapter, Dual ..... 105  
M03-206-604 3½" Rack Adapter, Triple ..... 105  
M03-205-605 3½" Rack Adapter, Quad ..... 85

### After-Warranty Service (See page 227)

SC1-731B, per 90-day interval ..... 100



750A

### 750A Reference Divider

- 10 ppm basic division ratio accuracy
- Switched input and output ranges
- Built-in kV for standard cell reference
- Overvoltage protection to 2 kV, any range

Model 750A Reference Divider is an extremely accurate and stable voltage divider for calibration of precision dc voltmeters, volt-boxes, dc calibrators, etc. The instrument is a 10 ppm (0.001%) divider with switched input taps ranging from 1100 to 1.1V, and switched output taps ranging from 1100V to 0.1V.

### Specifications

Input Voltages: (Switched) 1.1, 5, 10, 50, 100, 500, 1000, 1100V

Output Voltages: (Switched) 0.1, 0.5, 1, 1.1, 5, 10, 50, 100, 500, 1000, 1100V

Standardizing Output: 1.017000 to 1.019999V dc in 1 μV steps

Division Ratio Accuracy and Stability: (Referenced to Standard Cell tap) ±(0.001% of output +0.5 μV) for 1 year

Calibration: All ranges above 1.1V are adjustable ±10 ppm

Calibration Resolution: 0.2 ppm

Divider Current: 1 mA nominal

Input Current Adjust: Coarse and fine front-panel rheostats provide an input voltage adjustment span of 10 mV with better than 1 μV resolution

## STANDARDS &amp; AUXILIARY EQUIPMENT

750A/752A

**Overvoltage Protection:** Up to 2 kV may be applied on any range without damage

**Power:** Two 6.75V mercury batteries

**Size:** 8.8 cm H x 48.2 cm W x 33.0 cm D (3½ in x 19 in x 13 in)

**Weight:** 7.25 kg (16 lb)

## Model

January 1985 prices

750A Reference Divider ..... \$3530

## After-Warranty Service (See page 227)

SC1-750A, per 90-day interval ..... 300



752A

## 752A Reference Divider

- 10:1 and 100:1 division ratios
- Ratio accuracy of 0.2 ppm on 10:1 ratio
- Ratio accuracy of 0.5 ppm on 100:1 ratio
- Built in calibration bridge

The Fluke 752A Reference Divider sets new standards for dc voltage ratio accuracy and ease of use. It offers two divider outputs, 10:1 and 100:1 with output uncertainties of less than 0.2 ppm and 0.5 ppm respectively.

Before each use, the 752A is easily calibrated with only a stable voltage source and null detector. The entire procedure requires only five minutes and does not require external standards.

The 752A also includes internal switching for calibrating the 100 mV, 1V, 10V, 100V, and 1000V ranges of a voltage calibrator to a 10V reference source (such as the Fluke 732A DC Reference Standard) without having to change the lead connections. It provides the voltage division accuracy required to calibrate state-of-the-art

calibrators and similar instruments.

A "self-calibration" procedure allows you to compensate for long term changes in value of the divider resistors by switching their positions in various Wheatstone bridge configurations and using the BALANCE pot on the front panel.

## Specifications

These specifications apply for the lifetime of the instrument over the temperature range of 18°C to 28°C.

**Ratio Ranges:** 10:1 and 100:1

**Ratio Accuracy:** The following table specifies the ratio accuracies of the 752A that apply for a temperature variation of less than ±1°C from the self-calibration temperature (between 18°C and 28°C) for up to 8 hours following self-calibration.

Range	Input Voltage	Output Uncertainty	Null Accuracy*
10:1	100V	0.2 ppm	±0.5 μV
100:1	1000V	0.5 ppm	±1.0 μV

\* Null accuracy refers to the required accuracy of the null detector reading during self-calibration

**Temperature Coefficient:** ≤±1 ppm per °C from self-calibration temperature over range of 18°C to 28°C. Typically 0.1 ppm per °C from 15°C to 30°C

**Input Resistance**

10:1 Ratio: 380 kΩ ±1%

100:1 Ratio: Divider is 4 MΩ; Driven Guard is 4 MΩ; total is 2 MΩ ±1%

**Maximum Input Voltage:** 200V for the 10:1 ratio; 1100V for the 100:1 ratio

**Power Coefficient:** ≤0.05 ppm of output with 100V applied for 10:1 ratio and ≤0.3 ppm of output with 1000V applied for 100:1 ratio. Included in the ratio accuracy specifications

**Temperature:** 0°C to 50°C, operating; -40°C to 75°C non-operating

**Relative Humidity:** ≤75% to 40°C, ≤45% to 50°C, non-condensing

**Altitude:** ≤3050m (10,000 ft) operating; ≤12,200m (40,000 ft) non-operating

**Vibration:** Per MIL-T-28800C, Type III, Class 5, Style E

**Safety:** IEC 348, 2nd edition, 1978; ANSI-C39.5, 1980

**Size:** 19.1 cm H x 22.1 cm W x 60.3 cm L (7.53 in x 8.69 in x 23.75)

**Weight:** 8.4 kg (18.5 lb)

**Included:** Instruction manual

## Model

January 1985 prices

752A Reference Divider ..... \$3995

## Accessories (Also see page 230)

5440A-7003 Low Thermal Cables ..... 315

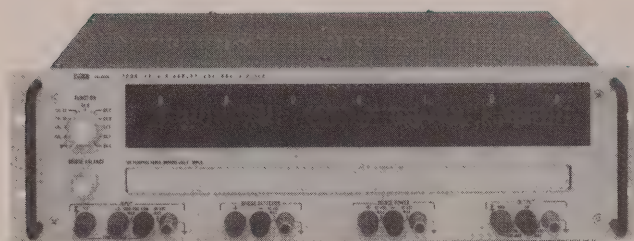
## After-Warranty Service (See page 227)

SC1-752A, per 90-day interval ..... 164



# STANDARDS & AUXILIARY EQUIPMENT

## 720A/721A



720A

### 720A Kelvin-Varley Divider

- 0.1 ppm resolution, seven decades
- 0.1 ppm of input absolute linearity
- Built-in self calibration bridge
- Front panel self calibration

Model 720A Kelvin-Varley Divider is a high-resolution primary ratio standard with absolute linearity of 0.1 ppm, temperature coefficient of linearity of 0.1 ppm/°C, and self-calibration capability.

The self-calibration procedure consists of equalizing the resistance steps of each of the first two decades by adjusting variable resistors accessible from the front panel. A Wheatstone bridge and the necessary switching are incorporated in the 720A so that the only external test units required are a stable source of dc and a sensitive null detector.

### Specifications

**Ratio Range:** 0 to 1.0 (1.0 input tap) and 0 to 1.1 (1.1 input tap)

**Resolution:** 0.1 ppm of input with seven decades

**Absolute Linearity:** (At calibration temperature and without the use of a correct chart)  $\pm 0.1$  ppm of input at dial settings of 1.1 to 0.1,  $\pm 0.1(10S)^{1/3}$  of input at dial settings (S) of 0.1 to 0

**Absolute Linearity Stability:** (Without self-calibration)  $\pm 1.0$  ppm of input/yr at dial settings of 1.1 to 0.1,  $\pm 1.0(10S)^{2/3}$  ppm of input/yr at dial setting (S) of 0.1 to 0

**NOTE:** Absolute linearity is defined as the linearity between max and min output voltages. The self-calibration procedure may be used at any time to reset absolute linearity to  $\pm 0.1$  ppm of input

**Temperature Coefficient of Linearity:**  $\pm 0.1$  ppm of input/°C maximum at dial settings of 1.1 to 0.1

**Short-Term Linearity Stability:** Under typical conditions in a standards laboratory environment (temperature maintained within  $\pm 1^\circ\text{C}$ ) and with an applied voltage of up to 100V, stability of linearity is 0.1 ppm/30 days

**Power Coefficient of Linearity:**  $\pm 0.2$  ppm of input/W max at dial settings of 1.1 to 0.1;  $\pm 0.2(10S)^2$  ppm of input/W max at dial settings (S) of 0.1 to 0

**Maximum End Errors:** Zero error at output low: 0.004 ppm of input. Zero error at input low: 0.05 ppm of input. Full-scale error: 0.05 ppm of input

**Thermal Voltages:**  $\pm 0.5 \mu\text{V}$  max

**Maximum Input Voltage:** 1000V on 1.0 input terminal, 1100V on 1.1 input terminal

**Input Resistance:** 100 k $\Omega$   $\pm 0.005\%$  at 1.0 input terminal at 25°C; 110 k $\Omega$   $\pm 0.005\%$  at 1.1 input terminal at 25°C

**Temperature Coefficient of Input Resistance:**  $\pm 1$  ppm per °C max

**Size:** 14 cm H x 48.2 cm W x 33 cm D, rack-mounted (5.5 in H x 19 in W x 13 in D)

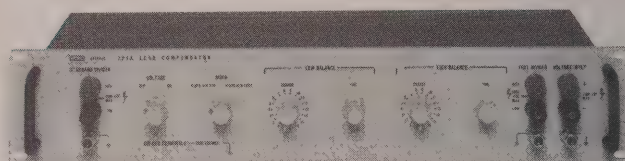
**Weight:** 8.16 kg (18 lb)

**Included:** Manual

### Model

January 1985 prices

720A Kelvin-Varley Voltage Divider ..... \$5610



721A

### 721A Lead Compensator

The 721A Lead Compensator equalizes the voltage drop across two resistive dividers connected in parallel for calibration. The errors due to contact and lead resistance are eliminated.

### Specifications

**Resolution of Resistance Compensation:** 0.1 m $\Omega$

**Maximum Ratio Between Divider Resistance:** 4000:1

**Maximum Allowable Lead Resistance:** 150 m $\Omega$

**Maximum Divider Voltage:** 1500V dc

**Size:** 8.9 cm H x 48.2 cm W x 15.2 cm D (3½ in x 19 in x 6 in)

**Weight:** 2.72 kg (6 lb)

**Included:** Manual

### Model

January 1985 prices

721A Lead Compensator ..... \$1345

### After-Warranty Service (See page 227)

SC1-721A, per 90-day interval ..... 68



845AR

### 845AB & 845AR Null Detector

- 19 ranges from 1  $\mu$ V through 1000V
- Input isolation greater than  $10^{12}$  ohms
- Input may be floated to 1100V above ground
- Overload protected to 1100V on all ranges
- Recorder output isolated from input

The Fluke 845AB and 845AR are solid-state null detectors designed for extremely high input impedance, sensitivity, and isolation. Model 845AB operates either from the line or from built-in rechargeable batteries. Model 845AR is a line-powered rack-mounting version, with a height of 3½ inches. Source loading through leakage is virtually eliminated by input isolation of  $10^{12}$  ohms regardless of power line, chassis ground, or guard connections. Recorder output provides  $\pm 1$ V dc for end-scale deflection with  $\pm 0.5\%$  linearity and does not affect input isolation. The 845AB and 845AR are capable of being floated up to 1100V dc from ground at either input terminal when used in a bridge circuit to compare voltage divider ratios. The unit withstands overloads up to 1100V dc on any range with a typical recovery time of four seconds.

### Specifications

**Range:** 1  $\mu$ V through 1000V dc end-scale in nineteen ranges, using 1, 3, 10 progression

**Input Resistance:** 100 M $\Omega$  on 300 mV range and above. 10 M $\Omega$  on 3 mV through 100 mV range, 1 M $\Omega$  on 1 mV range and below

**Accuracy:** Model 845AB  $\pm(2\%$  end-scale  $+0.1 \mu$ V). Model 845AR  $\pm(3\%$  end-scale  $+0.1 \mu$ V)

**Maximum P-P Meter Noise:** 0.20  $\mu$ V on 1  $\mu$ V range, 0.25  $\mu$ V on 3  $\mu$ V range, 0.3  $\mu$ V on 10  $\mu$ V to 1000V range, with input shorted

**Input Isolation:** Better than  $10^{12}$  ohms at  $\leq 50\%$  relative humidity and 25°C regardless of line, chassis, or recorder grounding. Better than  $10^{10}$  ohms up to 80% relative humidity and 35°C. With driven guard, isolation improves to at least  $10^{13}$  ohms. Either input terminal can be floated 1100V off chassis ground

**DC Common Mode Rejection:** Better than 160 dB, input short-circuited,  $\leq 80\%$  relative humidity; better than 140 dB, open-circuited,  $\leq 50\%$  relative humidity; better than 120 dB, open-circuited,  $\leq 80\%$  relative humidity

**AC Common Mode Rejection:** (Below 100 kHz) 100V rms or 120 dB greater than end-scale, whichever is less, will affect reading  $<2\%$  of end-scale (input open-circuited)

**AC Normal Mode Rejection:** (60 Hz and above) ac voltages 60 dB above end-scale will affect reading  $<2\%$  of end-scale. Maximum voltage not to exceed 750V rms

**Recorder Output:**  $\pm 1$ V dc at full scale deflection. Linearity, 0.5%. Output impedance, 5K to 7.5K. Recorder output is isolated from input and is referenced to ground

**Stability of Zero:** Better than 0.15  $\mu$ V/hour; better than 0.3  $\mu$ V/day  
**Overload Capability:** Up to 1100V dc may be applied on any range. Typical recovery time is 4s

**Power, Model 845AR:** 115 or 230V ac  $\pm 10\%$ , 50 to 440 Hz, approx. 3W  
**Power, Model 845AB:** 115 or 230V ac  $\pm 10\%$ , 50 to 440 Hz or rechargeable battery. Approximately 6W during recharge. 40 hr operation on full charge. Batteries trickle-charge while instrument operates from power line

**Size, Model 845AB:** 17.8 cm H x 21.6 cm W x 20.3 cm D (7 in H x 8.5 in W x 8 in D)

**Size, Model 845AR:** 8.9 cm H x 48.3 cm W x 21 cm D (3.5 in H x 19 in W x 8.25 in D)

**Weight:** Model 845AB: 4.65 kg (10.25 lb); Model 845AR: 4.08 kg (9 lb)

### Model

January 1985 prices

845AB Voltmeter/Null Detector with batteries .....	\$2000
845AR Voltmeter/Null Detector .....	1860

### Accessories (for 845AB only) (Also see page 230)

881A-102 7" Rack Adapter, Single .....	145
881A-103 7" Rack Adapter, Dual .....	100

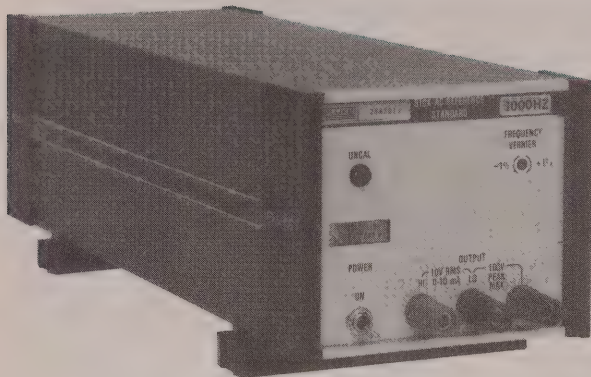
### After-Warranty Service (See page 227)

SC1-845AB, per 90-day interval .....	132
SC1-845AR, per 90-day interval .....	132



## STANDARDS &amp; AUXILIARY EQUIPMENT

## 510A/540B



510A

## 510A AC Reference Standard

- Uncertainty to  $\pm 100$  ppm
- Optional battery operation
- Output voltage 10V rms
- Output current levels to 10 mA rms
- Fixed frequency, 50 Hz to 100 kHz

The 510A is a precision, fixed frequency, ac voltage source designed for use as an amplitude calibration standard for test applications. In the calibration laboratory, the 510A provides an accurate ac reference for calibrating both true rms and average-sensing ac voltmeters. On the production line, the 510A can be used to rapidly verify ac test instrumentation or to generate a precise ac stimulus for circuit testing.

Output of the 510A is both fixed frequency and fixed amplitude. The frequency may be varied  $\pm 1\%$  of center frequency with a front panel screwdriver adjustment.

Total harmonic distortion is less than 50 ppm up to 50 kHz, and less than 150 ppm at 100 kHz. This assures a pure sine wave for calibrating average, peak, or true rms reading ac-to-dc converters.

The optional rechargeable battery pack provides up to 16 hours of operation independent of line power. A front panel display provides a continuous display of battery condition. When operated from line power, the battery is maintained at full charge. The battery automatically operates the 510A whenever line power is removed.

Up to four 510As may be bolted together for mounting in a standard rack. Output terminals are provided on both the front and rear panels for easy access in both bench and system applications.

Amplitude Stability:  $\pm$ ppm

Frequency	24 Hours	30 Days	90 Days
50 Hz to 20 kHz	20	50	100
20 kHz to 100 kHz	40	100	200

Total Harmonic Distortion: Less than 50 ppm to 10 kHz; less than 150 ppm at 100 kHz

Center Frequency Uncertainty:  $\pm 0.1\%$ , adjustable  $\pm 1\%$

Frequency Stability: 500 ppm per mo

Load Regulation:  $\leq 20$  ppm to 10 kHz;  $\leq 80$  ppm at 100 kHz

Line Regulation:  $\leq 10$  ppm for  $\pm 10\%$  line change

Input Power: 115 or 230V ac  $\pm 10\%$ , 50 to 500 Hz, or optional rechargeable batteries

Size: 8.8 cm H x 10.7 cm W x 30.4 cm D (3.5 in H x 4.25 in W x 12 in D)

Weight: 2.26 kg (5 lb)

Included: Instruction Manual

## Model

January 1985 prices

510A\* AC Reference Standard ..... \$1550

510A-01\* AC Reference Standard w/battery pack ..... 1770

510A/SF\* AC Reference Standard (Special Frequency) .... on req.

510A-01K Rechargeable Battery Pack (for retrofit) ..... 365

\*Specify output frequency when ordering

## Accessories (Also see page 230)

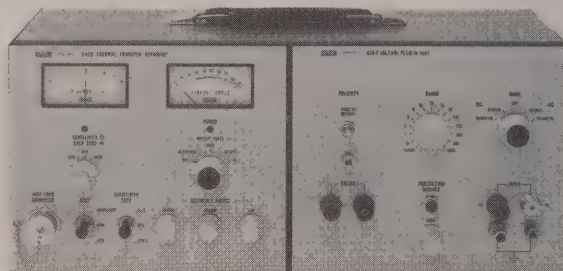
M03-201-601 Rack Mount Kit, Single ..... 105

M03-202-603 Rack Mount Kit, Dual ..... 105

M03-205-605 Rack Mount Kit, Quad ..... 85

## After-Warranty Service (See page 227)

SC1-510A, per 90-day interval ..... 108



540B

## 540B Thermal Transfer Standard

- 100 ppm ac/dc transfer uncertainty
- Less than 100 ppm dc reversal error
- Frequency range 5 Hz-1 MHz
- Overvoltage protection
- Polarity reversal switch

The Fluke 540B is a thermal transfer instrument for precise measurement and calibration of ac voltage and current. The 540B is designed for simple operation with positive protection from overloads. Voltage transfers may be made from 0.25V to 1000V rms ac in 14 ranges, with a frequency range from 5 Hz to 1 MHz. Each range maintains specified accuracy down to half of range. Resolution of input per scale division varies from 12 ppm at full range to 60 ppm at half of range. Basic ac to dc transfer uncertainty is 100 ppm

## Specifications

Output Voltage: 10V rms

Output Current: 10 mA rms, short-circuit protected

Frequency: Any specified single frequency from 50 Hz to 100 kHz. Standard frequencies are: 50, 60, 400, 1000, 2400, 5000, 19,200, and 100,000 Hz

Amplitude Uncertainty:\*  $\pm$ ppm

Frequency	24 Hours	30 Days	90 Days
50 Hz to 20 kHz	100	150	200
20 kHz to 50 kHz	150	250	350
50 kHz to 100 kHz	400	500	600

\*After 10-minute warm-up in ambient temperature 21°C to 25°C

## STANDARDS &amp; AUXILIARY EQUIPMENT

540B/A40/A40A

( $\pm 0.01\%$ ) without the use of calibration curves or correction tables.

The thermal element in the 540B is a specially constructed vacuum thermocouple protected from overvoltage. Up to 1500V dc or rms ac may be applied on any range without damage. A pushbutton protection disable switch allows confirmation that diode aging in protection circuitry is not contributing to error.

Three galvanometer sensitivity settings are provided. A sensitivity test function provides momentary galvanometer deflection for 0.1% and 0.01% of input voltage, at any galvanometer sensitivity setting.

The 540B includes a meter-display search function, for continuous visual indication of input percent of range. The search function indicates when the overload circuit has activated, by deflecting upscale into a red "overload" area. After an overload condition, the 540B is returned to normal operation simply by setting the mode switch to "off."

The basis of transfer comparison in the 540B is always 1:1; ac and dc voltages are placed across the same transfer circuit. In this way, accuracy is independent of range division ratios.

Dc reversal error in the thermocouple is less than 100 ppm (0.01%) of input voltage at full range. A convenient "push-to-reverse" switch is provided to reverse dc input polarity.

A high frequency thermal converter input jack is provided so that the galvanometer and Lindeck reference supply may be used with Fluke Model A55 High Frequency Thermal Converters.

The 540B operates from rechargeable nickel-cadmium battery cells for complete isolation from line power. Fully charged, the 540B may be operated for up to 200 hours without an interruption for charging.

## Calibration

Each range is adjusted to be within the specified deviations from zero error as defined by reference standards maintained by the Fluke Standards Laboratory and periodically calibrated by the U.S. National Bureau of Standards. These ac/dc difference figures do not include U.S. National Bureau of Standards' random and systematic errors. Fluke test reports to the nearest 100 ppm are available at extra cost upon request.

## Characterization

Model 540B-900 is a 32-point characterization of a new 540B Thermal Transfer Standard. Model 540B-901 is the same characterization service for a customer-owned 540B, available through Fluke Technical Service Centers. All characterizations are actually performed by the John Fluke Standard Laboratory in Everett, Washington. This 32-point characterization is intended to support customers who wish to characterize 5200A ac calibrators as required by 5200A-800 Enhancement Software.

Special characterizations to meet specific calibration requirements are also available. Consult your local Fluke Sales Office for further information.

## Specifications

**Voltage Ranges:** 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, and 1000V, with each range useable from  $\frac{1}{2}$  to 1 times rating

### Uncertainty

Frequency Hz	Voltage Ranges			
	0.5 - 10V	20V - 50V	100V - 500V	1000V
5-20k	$\pm 0.01\%$	$\pm 0.01\%$	$\pm 0.01\%$	$\pm 0.02\%$
20k-50k	$\pm 0.01\%$	$\pm 0.01\%$	$\pm 0.01\%$	$\pm 0.04\%$
50k-100k	$\pm 0.05\%$	$\pm 0.05\%$	$\pm 0.20\%$	X
100k-500k	$\pm 0.10\%$	$\pm 0.10\%$	X	X
500-1M	$\pm 0.10\%$	X	X	X

**Search Function:** Meter display of input as percentage of range

**Input Impedance:** 180 $\Omega$ /V

**Polarity:** Reversible, front panel push-button

**Galvanometer:** Fluke electronic type

**Galvanometer Resolution:** 12 ppm of input/scale division at full range; 60 ppm of input/scale division at half range

**Thermocouple Reversal Error:**  $\leq 100$  ppm of input at full range;  $\leq 300$  ppm at half range

**Overload Protection:** Withstands up to 1500V dc or rms ac, any range

**Power:** 115V or 230V ac  $\pm 10\%$ , 50 to 440 Hz, 7W; self-contained rechargeable batteries; 200 hours operation, 16 hours recharge time

**Size:** 17.2 cm H x 41.7 cm W x 19 cm D (7 in H x 17 in W x 7.75 in D)  
**Included:** Instruction manual, coaxial input cable

## Model

January 1985 prices

540B Thermal Transfer Standard ..... \$4890

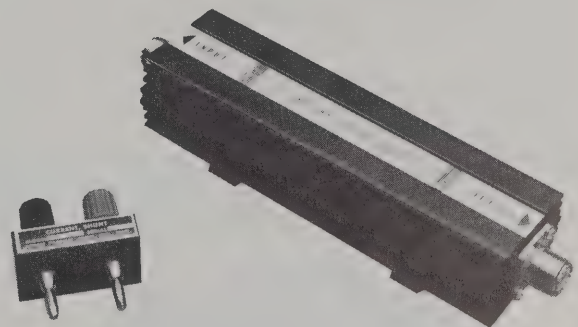
## Accessories

540B-103 7" Rack Adapter ..... 110

540B-110 Rechargeable Battery Pack (retrofit kit) ..... 390

## After-Warranty Service

SC1-540B/A54, per 90-day interval ..... 432



A40/A40A

## A40 and A40A Current Shunts

- Ac current transfer measurements from 2.5 mA to 20A
- Frequency response from 5 Hz to 100 kHz
- Designed for use with Model 540B

Models A40 and A40A Current Shunts make possible accurate ac current transfer measurements using the Model 540B Thermal Transfer Standard. Measurements may be made over a 2.5 milliamperes to 20 ampere range with a frequency response from 5 Hz to 50 kHz. Measurements to 100 kHz may be made up to 5 amperes.

Twelve A40 current shunts are available with current ratings from 10 milliamperes to 5 amperes. A40A shunts are available with current ratings of 10 and 20 amperes. Each shunt maintains specified accuracy down to half its rated current level. With no shunt in place, the 540B may be used directly for current transfer measurements from 2.5 milliamperes to 5 milliamperes.

A40 shunts plug into panel connectors on the 540B. A40A shunts require special cables, available separately.

## Calibration

All ac/dc differences expressed in the specifications are deviations from standards maintained by the U.S. National Bureau of Standards, and may be obtained without the use of calibration curves or correction tables. When properly used with a Fluke 540B Thermal Transfer Standard, each A40 and A40A Current Shunt is within the



# STANDARDS & AUXILIARY EQUIPMENT

## A40/A40A/A55

specified deviation from zero error, as defined by reference standards maintained by the John Fluke Standards Laboratory and periodically calibrated by the U.S. National Bureau of standards. These ac/dc difference figures do not include U.S. National Bureau of standards random and systematic errors. Fluke test reports to the nearest 100 ppm (0.01%) are available at extra cost upon request.

### Specifications

**A40 Current Ratings:** 10, 20, 30, 50, 100, 200, 300, and 500 mA; 1, 2, 3, and 5A

**A40A Current Ratings:** 10 and 20A

#### Uncertainty

Frequency	AC/DC Difference	
	A40	A40A
5 Hz - 20 kHz	±0.02%	±0.03%
20 kHz - 50 kHz	±0.03%	±0.05%
50 kHz - 100 kHz	±0.05%	

### Model

January 1985 prices

**A40\* Current Shunts** ..... \$430

**A40A\* Current Shunts** ..... 430

\*Order by current rating, eg: A40-50 MA. Price is for each shunt

### Accessories

**A45-4003 Input Cable for A40A Shunts** ..... 60

**A45-4004 Output Cable for A40A Shunts** ..... 90

**Y8133 Test Lead Kit for A40 Shunts** ..... 20

**C41 Storage Case** ..... 535



A55

### A55 High Frequency Thermal Converters

- Useable to 50 MHz
- Designed for use with Model 540B

Model A55 Thermal Converters make possible accurate thermal-transfer ac measurements from subaudio frequencies to the VHF region. The design is comparable to that of standards maintained by the U.S. National Bureau of Standards.

Designed for use with the Model 540B Thermal Transfer Standard, nine model A55 Thermal Transfer Standards are available to match each 540B voltage range from 0.25V to 50V. The 540B includes a compatible connector that bypasses its internal transfer circuit, using only the null detector and reference supply. Each A55 converter maintains specified accuracy down to half its rated voltage.

A specially constructed thermocouple, selected for frequency characteristics and low dc reversal error, is the thermally responsive element. Input voltage is applied directly across the thermocouple

heater on the 0.5V model. For higher voltages, coaxial mounted low temperature-coefficient metal film resistors are used in series with the heater.

### Certification

Each A55 converter includes a Fluke production test record of ac/dc differences at 1, 10, 20, and 30 MHz. A55 converters rated below 20V also include a production test record of ac/dc difference at 50 MHz. Fluke test reports at other frequencies and voltages are available at extra cost upon request. Ac/dc differences are established to within ±100 ppm by comparison to Fluke standards that are periodically intercompared with the U.S. National Bureau of standards.

### Accessory Kit

The Model A55-110 Accessory Kit is recommended for use with A55 Thermal Converters in virtually any calibration or measurement setup. The kit includes:

- Coaxial tee for A55 input (GR type 874-TL).
- Three coaxial adapters for A55 input: UHF, BNC, and type N jack.
- Interconnecting coaxial cable, ac source to coaxial tee.

### Specifications

**Voltage Ratings:** 0.5, 1, 2, 3, 5, 10, 20, 30, and 50V\*

\*Each converter is useable from 1/2 to 1 times its rated voltage

#### Uncertainty:

Frequency	Calibration Uncertainty*	Typical AC/DC Difference
<1 MHz		<±0.01%
1 MHz	±0.05%	±0.01%
10 MHz	±0.10%	
20 MHz	±0.15%	±0.02%
30 MHz	±0.20%	±0.10%
50 MHz**	±0.50%	±0.30%

\* All calibration is referenced to center of GR874-TL coaxial tee attached to converter input connector

\*\* 50 MHz calibration available only for 0.5, 1, 2, 3, 5, and 10V converters

**Input Impedance:** 200Ω/V, approximate

**Output Voltage:** 7 mV nominal, at rated input

**Output Resistance:** 8Ω

**Reversal Error:** <250 ppm (0.025%)

**Input Connector:** GR type 874-TL

**Output Connector:** Amphenol 80-PC2M (2-pin microphone)

**Size and Weight**

Converters	Diameter cm	Length cm	Weight gm
0.5V	3.5	8.4	28
1V, 2V	3.5	13.2	370
3V, 5V	3.5	16.5	430
10V, 20V	3.5	17.9	450
30V, 50V	3.5	17.9	450

**Included:** Instruction manual and certification (see above)

### Model

January 1985 prices

**A55\* High Frequency Thermal Converter** ..... \$535

\*Order by voltage rating, eg: A-55 -0.5V. Prices are for each converter

### Accessories

**A55-110 Accessory Kit** ..... 535

**C55 Storage Case** ..... 535

### Why Computer-Aided Calibration?

Calibration labs today are more than ever being caught in the perennial problem of needing to do more, in less time, with less money, and fewer people. Calibration workloads are increasing yet trained technicians are getting harder to find. Cal lab managers are constantly seeking out new ways to relieve these problems.

Fortunately, cal labs do have the option of turning to computer-aided calibration. Computer-aided calibration means just what it says. A computer or instrument controller aids calibration by controlling the calibration instruments via an IEEE-488 bus and by giving operator instructions via menu driven prompts. A good computer-aided calibration system is traceable to national standards, can be used in local area networks, can control the test instrument (TI), and record calibration results automatically.

### Computer-Aided Calibration Gives Needed Relief

Computer-aided calibration minimizes the need to have highly trained technicians perform repetitive calibration tasks. Instead, people with limited calibration background can produce useful results with abbreviated learning curves. Your skilled technicians can be saved for more complicated tasks like repair and troubleshooting.

Quality of calibration is also improved through automation. Since the computer guides calibration, repeatability of calibration events is ensured — a critical factor in a time of stricter calibration regulations.

In summary, computer-aided calibration reduces the cost per calibration due to time savings from increased throughput, automatic results recording, and better personnel management. Computer-aided calibration also improves the uniformity of the calibrations and provides automated results data management.

### Get Control of Your Time and Your Calibration

How do you know if you would benefit from computer-aided calibration? If you see your workload getting out of control, that is a good indication. Or, if you see a need for more people and are having trouble finding skilled people, that is another indication. You may also need computer-aided calibration if you are facing increasing regulations and a need for greater documentation.

If your lab performs verification checks prior to adjusting the TI, you will especially benefit from computer-aided calibration because it provides greatly increased throughput. Computer-aided calibration also helps an operator adjust older TIs faster, while fully automating the adjustment of the new generation of software calibrated TIs.

### Computer-Aided Calibration For Every Need

Fluke has been a forerunner in computer-aided calibration for over fourteen years. This year the best gets better. In the following pages you will find a wider variety of automated solutions to your calibration needs than ever before available. From computer-aided benchtop clusters to the world's most accurate automated calibration workstations, Fluke brings a fresh approach to calibration.

### Fluke Computer-Aided Calibration Selection Guide

Building Blocks for Computer-Aided Calibration		Applications Summary							
		Computer-Aided Bench-Top Clusters			Automated Calibration Workstations				
		Do-It-Yourself	7404B <sup>3,4</sup>	7449A <sup>1,3</sup>	7405A	7410A	A123	A144	7405A/AC
Model	Description	Page 133	Page 135	Page 137	Page 138	Page 142	Page 146	Page 146	Page 146
7411A	Calibration Software <sup>1</sup>	#	#	#	#	#	#	#	#
1722A	Instrument Controller	#	#	#	#	#	#	#	#
7465A/AA	Winchester Disk Drive <sup>2</sup>	•	•	•	•	•	•	•	•
	Line Printer	•	•	•	•	•	•	•	•
5100B	Multifunction Calibrator	•	#	#	#	—	•	#	#
5200A	Precision 6-Digit aV Calibrator	•	—	—	—	—	#	—	—
5205A	Precision Power Amplifier	•	•	•	•	—	•	—	•
5215A	Precision Power Amplifier	•	—	—	—	—	#	—	•
5220A	Transconductance Amplifier	•	•	•	•	—	•	—	•
5440B	Precision Direct Voltage Calibrator	•	—	—	•	—	#	#	—
5450A	Resistance Calibrator (1Ω-100M)	•	—	—	•	—	#	#	—
C65001	Oscilloscope Calibrator (Tektronix)®	•	—	#	—	#	•	—	—
1953A	Frequency Counter/Timer	•	—	—	•	—	•	—	•
6011A	Signal Generator (10 Hz-11 MHz)	•	—	—	—	•	•	—	—
6060A	Signal Generator (400 kHz-1.05 GHz)	•	—	—	—	•	•	—	—
6070A	Signal Generator (200 kHz-520 MHz)	•	—	—	—	•	•	—	—
6071A	Signal Generator (200 kHz-1.04 GHz)	•	—	—	—	•	•	—	—
8505A	Digital Multimeter	•	—	—	#	—	—	—	#
8506A	Digital Multimeter	•	#	#	—	—	•	#	—
8520A	Digital Multimeter	•	—	—	—	#	—	—	—
Calibration Capabilities:									
	3.5, 4.5 Digit Meters	+	+	+	+	—	+	+	+
	5.5, 6.5 Digit Meters	+	+	+	—	—	+	+	—
	Oscilloscopes	+	—	+	—	+	+	—	—
	Power Supplies	—	—	—	—	—	+	—	—
	Mobile Calibration	+	+	+	—	—	+	+	+

# Standard • Optional + Capabilities

1. Available spring 1985

2. Available summer 1985 for use with 7411A

3. 7404B and 7449A are compatible with do-it-yourself expansion

4. 7404B software is compatible with 7411A



# COMPUTER-AIDED CALIBRATION

## Introduction

### Computer-Aided Benchtop Clusters

Computer-aided benchtop clusters are collections of instruments that reside on a workbench and are used for calibration. The collection of instruments is usually not rack-mounted and may not be under formal configuration control, but is compatible with being controlled by the IEEE-488 bus. The Computer-Aided Calibration Selection Guide identifies a wide variety of Fluke instruments that can be used in a computer-aided benchtop clusters via the addition of a Fluke 1722A Instrument Controller and Fluke 7411A Calibration-at-a-Keystroke software.\*

*\*Available in the spring of 1985*

### Standard or Special Automated Calibration Workstations

Fluke also provides complete automated calibration workstations to fill state-of-the-art calibration requirements. An automated calibration workstation contains rack-mounted instruments, is assigned a specific Fluke model number and is under configuration control. A computer-aided benchtop cluster is upwardly compatible with expansion into an automated calibration workstation.

Our automated calibration workstations give you fully integrated, automated calibration with the benefits of convenient test interface panels. You get fully configured, computer-aided calibration software, the instruments of your choice from the Computer-Aided Calibration Selection Guide, and full rack integration. These workstations include instrument configurations demanded by metrologists around the world.

Fluke offers both standard and special automated calibration workstations for meters or oscilloscopes. Standard workstations are configured at Fluke to maximize the system capabilities of the integrated instruments. Standard workstations include the 7405A and 7410A. The Fluke 7405A is a fully configured automated meter calibration workstation. The Fluke 7410A is an automated oscilloscope calibration workstation. These workstations are discussed in greater detail in the following pages.

Fluke will also configure special workstations to fit your own particular needs. From combined meter/oscilloscope workstations, to mobile calibration workstations, to the world's most accurate meter calibration workstation, Fluke offers what you need to do your job. The instruments available with these workstations are covered in the Computer-Aided Calibration Selection Guide.

## Computer-Aided Benchtop Clusters — Using Fluke Calibration Software, Controllers & Instruments

- Calibration-at-a-Keystroke software
- User configurable
- Automation of both meter and oscilloscope calibration
- Automated ease with benchtop convenience
- Enables accurate, repeatable calibration tests
- Complete results and calibration data management
- Allows efficient use of technical personnel

Computer-Aided Benchtop Clusters are automated combinations of unracked calibration instruments controlled by the IEEE-488 bus. Thanks to Fluke Model 7411A Calibration-at-a-Keystroke software, you can define the instruments you want to automate in a benchtop cluster. Consult the chart on page 129 to select the benchtop instruments you would like to automate. Then use Fluke 7411A Calibration-at-a-Keystroke software to transform the instruments from stand-alone manual mode, to full automation under the control of the Fluke 1722A Instrument Controller.

For example, if you wish to automate your oscilloscope and 4½-digit meter calibration, we provide software to drive the Fluke 5100B and the Tektronix CG5001 Calibrator. If you would like high accuracy measurement, you can add the Fluke 8506A to this group. This software would be ordered as the 7411A-800 along with the 7400A-993 (the 1722A with 512K byte RAM and additional I/O) and the desired instruments.

Your computer-aided benchtop cluster will give you all the benefits of automated calibration — ease of use, automatic data recording, and reduced cost per calibration.

## The Best of Both Worlds

Calibration instruments on the bench have two modes of operation: local (operated manually) and remote (automated control). Manual control gives you direct access to the instrument controls. Automated control lets the computer do the work. Fluke computer-aided benchtop clusters give you the best of both worlds.

Fluke 7411A Calibration-at-a-Keystroke software guides you through automated calibration procedures. These procedures control your benchtop cluster of instruments in performing accurate calibrations of your test equipment. Instructions to the operator are presented on the 1722A screen. Any responses from the operator are made through the convenient, touch-sensitive screen.

Computer-aided benchtop clusters also give you easy, direct access to your instruments for single tests. But automation of your benchtop cluster gives you added benefits stand-alone instruments cannot give.

Since the controller instructs the operator during each calibration, operators with less experience can perform calibration effectively. This is critical today when experienced technicians are getting hard to find.

Automated calibration is based on standard procedures you tailor to fit your calibration philosophy. These computer-aided procedures guarantee repeatability of your calibration tests — a feature absolutely necessary to satisfy stiffening government requirements. Plus, your system will record complete calibration results. You no longer need to spend time hand recording data.

## Fluke Model 7404B For Calibrating Five Digit Meters

Fluke Model 7404B is a computer-aided bench-top cluster of instruments that automatically directs a Fluke 8506A DMM to measure the aV and dV outputs of the Fluke 5100B and, under program control, enhance their accuracy to 20 ppm for dV and 200 ppm for midband aV. These accuracies are sufficient to calibrate most models of 5 digit DMMs. In addition a procedure, available from Fluke, provides a factory approved 'closed-loop' calibration of the Fluke Model 8840A DMM via software correction factors transmitted over the IEEE-488 bus to the 8840A.

Fluke Model 7411 software is used with a 1722A, 5100B and 8506A to form the 7404B Bench-Top Cluster. You can order the 7404B as a complete package from Fluke or you can construct it yourself from instruments you already own or obtain from Fluke. The 7404B is circled on the following page.

## Fluke Model 7449A For Calibrating Meters and Oscilloscopes

Fluke Model 7449A adds a Tektronix CG5001 Oscilloscope Calibrator to the 7404B to provide all of the 7404A meter calibration features plus the oscilloscope calibration capability of the CG5001. The 7449A is available as a complete package from Fluke or its constituent elements can be ordered from Fluke and Tektronix. The 7449A is also circled on the following page.

## Configuring Your Own 7411A Based Computer-Aided Benchtop Cluster

Fluke 7411A Based Computer-Aided Benchtop Clusters are easy to configure, merely by following these steps:

1. Determine your calibration requirements. Select the instruments you wish to integrate from the guide (on page 129). These instruments may already be in your cal lab or you can purchase them new.
2. Order the 7411A software package. This will give you all the software capability necessary to drive any of the instruments in the guide (on page 129).
3. Order the 7400A-993 Option. This will give you the 1722A Instrument Controller appropriately configured for your 7411A. If you already have a 1722A, be certain you have the 1722A-007 (512K byte RAM) (512K byte RAM) and 1722A-008.
4. If you need additional IEEE-488 cables, order the Y8021, Y8022, or Y8023 for 1, 2, or 4 meter lengths.

## Typical Complete Package

**7411A:** 7411A Software Package with manuals.

**7400A-993:** 1722A Instrument Controller with 512K byte RAM and additional RS-232/IEEE-488 port.

**7400A-997:** 1722A compatible Operator's Aid

**7400A-300:** Printer Package: Printer, Stand, Paper Tray, Cable, Paper

**Y8021** 1m cable for IEEE-488 bus

**Y8022** 2m cable for IEEE-488 bus

**Y8023** 4m cable for IEEE-488 bus



Increasing Capability

Computer-aided instrumentation

5100B

1722A 5100B

8506A 1722A 5100B Available as 7404B Including software

CG5001 1722A 8506A 5100B Available as 7449A including software

CG5001 1722A 8506A 5100B 5220A 5205A

CG5001 1722A 8506A 5100B 5220A 5205A

CG5001 1722A 8506A 5450A 5440A

CG5001 6060A 1722A 8506A 5450A 5440A

CG5001 6060A 5215A 5200A 1722A 8506A 5450A 5440A

Computer-aided meter cal

Computer-aided hi accuracy meter cal

Computer-aided hi accuracy meter, scope cal

Computer-aided hi accuracy meter with hi I, hi V, scope cal

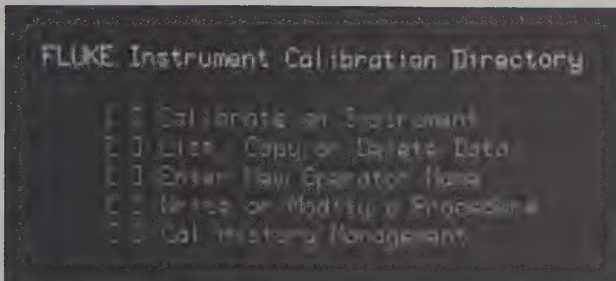
Computer-aided hi accuracy meter, scope, bandwidth cal

Computer-aided higher accuracy meter cal with aV, scope, bandwidth

## COMPUTER-AIDED CALIBRATION

## Benchtop Cluster 7411A

NEW



## Model 7411A Calibration-at-a-Keystroke Software

Fluke Model 7411A is a menu-driven software package that's specifically designed to provide a complete calibration capability for most meters and oscilloscopes and a limited ability to calibrate power supplies, frequency counters and instrumentation amplifiers. It runs in the Fluke 1722A Instrument Controller and is used in conjunction with calibration procedures that utilize members of the Fluke family of IEEE-488 programmable calibrators, precision DMMs and signal generators.

Model 7411A is primarily designed to be used by two types of users. One is a procedure writer who knows how to write calibration procedures in technical English. The procedure writer does not need to know how to program computers to write the procedures.\* A non-technical operator of an automated calibration workstation (or computer-aided benchtop cluster of calibrators) is the other user.

In many environments, calibration technicians are the procedure writers. They communicate with Model 7411A via the touch sensitive CRT and keyboard of the 1722A. Model 7411A prompts the procedure writer to enter the data required to implement the calibration of a particular instrument, such as a DMM. Data includes messages to the operator that will be displayed on the 1722A's CRT, nominal value and tolerance of stimulus for each test event and, when appropriate, IEEE-488 bus commands for the instrument under test. Completed procedures are permanently filed on magnetic media, such as floppy diskettes.

Model 7411A provides a number of error checking features that are intended to reject procedural data that's incompatible with the capabilities of the workstation it controls. For example, Model 7411A won't allow a procedure to ask for a stimulus instrument to supply a greater level of output than it's able to output. It also provides error messages at calibration time.

At calibration time, the Model 7411A uses the procedural data to execute a complete test event or even a complete test procedure upon receipt of a single keystroke from a workstation operator. It is used in workstations or computer-aided instrument clusters that are controlled by a Fluke 1722A Instrument Controller. Model 7411A uses the data in the procedure to communicate with the workstation operator via the 1722A's touch sensitive CRT and a small keypad used in lieu of the procedure writers keyboard.

The operator cannot modify the procedure, skip portions of the procedure, or otherwise change the sequence of calibration events except as permitted by the procedure writer. The 7411A uses the data to direct the operator to connect the test instrument (TI) to the workstation, program workstation stimulus, direct the operator to slew the stimulus via the keypad/touch-sensitive CRT in order to make the TI read the nominal value, evaluate the test results, store the test data on magnetic media and provide printouts. When the TI is IEEE-488 programmable, workstation stimulus is not slewed. Instead, the TI's response is input to the 7411A via the IEEE-488 bus for evaluation.

*\*Use of certain advanced, optional features of the 7411A do require the procedure writer to write BASIC programs for the 1722A.*

## Specifications

**Basis of Specifications:** The specified capabilities of the Model 7411A may be improved, increased, or revised. Changes will be onwardly compatible from current versions to future versions of Model 7411A but they won't necessarily be reverse compatible.

**Major Capabilities:** Calibrate an instrument; list, copy, or delete data; enter new operator name; write or modify a procedure; cal history management (optional)

**Calibrate An Instrument:** Enter TI serial number, enter TI property code, execute the procedure, record the test results

**Executing A Procedure:** The following capabilities are available during the execution of a procedure. Their implementation is usually at the discretion of the procedure writer

**Text and Simple Graphics:** Text and simple graphics are displayed on the 1722A CRT, for the operator and are apropos of:

**Connecting the TI to the workstation**

**Setting the TI to the appropriate range and function**

**Slewing the workstation stimulus via the keypad or the touch sensitive CRT in order to make the TI read a nominal value**

**Entering data, such as the TI reading, via the touch sensitive CRT**

**Displaying the test results**

**Entering a Remark about the test via the touch sensitive CRT**

**Advancing, Repeating, Branching or Terminating the procedure**

**Types of Instruments Tested:**

**Manual:** Instruments whose tests require operator interaction with the workstation during the test events

**IEEE-488:** Compatible instruments that are 'closed-loop' tested with little or no operator interaction during the test events

**Calibration Modes:**

**Performance Verification:** In this mode, the performance of the TI is checked and the results are recorded. No adjustments are permitted

**Calibration With Adjustment:** In this mode, the performance of the TI is checked, its calibration is adjusted and the results are recorded

**Types of Tests:** Normal, Setup, Nominal Setup, Compare

Normal, Nominal Set, and Compare tests are usually used in conjunction with manually operated TIs. In these tests, the workstation operator slews its stimulus via the keypad or touch sensitive CRT in order to perform the evaluation. In Normal tests, the TI's performance is evaluated immediately after slewing. In Nominal Set tests, slewing establishes a reference reading on the TI. This reading isn't evaluated and the test is concluded by a Compare test wherein slewing may also occur. The final reading of the Compare test is compared to the final reading of the Nominal Set test, rather than to a nominal value. Bandwidth testing of an oscilloscope is an applications example of these two tests.

Setup tests are normally used for 'closed-loop' calibration of IEEE-488 compatible TIs.

**Recording Results:** Test event results can be recorded via a printer as described under the subheading List, Copy, or Delete Data

**List, Copy, or Delete Data:** Data includes Procedures and test Results  
**List:** Procedures, Results, and Diskette Catalogs can be displayed on the 1722A CRT or be listed on a RS-232-C compatible printer. All or selected Procedures or Results can be displayed or listed

**Copy:** Procedures and Results can be copied from disk to disk and to or from remote devices such as another computer in a Local Area Network

**Delete:** Procedures and Results can be deleted from Disks

**Enter New Operator Name:** A workstation operator uses this utility to enter his or her name via the touch sensitive 1722A CRT for use in the header of the Results display or printout. The name on the printout will be the last name entered



# COMPUTER-AIDED CALIBRATION

## Benchtop Cluster 7411A

**Write or Modify a Procedure:** The 7411A interacts with a procedure writer via both the 1722A's touch sensitive CRT and its ASCII keyboard to generate test procedures. The CRT displays Function Selection Codes (FSC). The procedure writer touches one of these and is then prompted to enter appropriate alphanumeric data from the ASCII keyboard. A Procedure Writers Manual assists the procedure writer to select the proper data for each FSC. The 7411A tests the data for completeness and accuracy and then stores it in a procedure data file. The data file is copied onto disk in order to save it permanently.

### Function Selection Codes (FSC):

**Instrument Oriented Evaluation FSCs:** These are used directly in conjunction with the workstation instrumentation to evaluate a TI's performance. They are identified on the 1722A's CRT as either the model number of an instrument in the workstation, e.g., 5100B or as a generic type of instrument, e.g., DMM.

**Workstation Oriented Evaluation FSCs:** These are used indirectly with the workstation instrumentation to evaluate a TI's performance. For example one of these allows the user to RUN a BASIC program by calling it from a procedure in order to evaluate a test result that can't be handled by an instrument oriented FSC. Another allows the procedure writer to take advantage of the MEMory capabilities of the Workstation Oriented Transparent FSCs in order to indirectly evaluate a TI.

**Workstation Oriented Transparent FSCs:** The workstation operator does not interact with these during test events. The procedure writer uses them to manipulate the contents of the 7411A's MEMory during testing, enable optional operator movement in a procedure, CALL other procedures from the present procedure, RUN BASIC programs from the present procedure and suppress or enable various automatic features of the 7411A.

**Message Oriented FSCs:** These are used to display messages and graphics to the workstation operator via the 1722A's CRT, to accept alphanumeric inputs from the workstation operator via the 1722A's touch sensitive key pad, to transceive data on both of the 1722A's IEEE-488 ports and on both of its RS-232-C ports.

### 7411A-001 Calibration History Management, [optional]

This option is a data management utility for manipulating Results data to create user defined reports. It allows its user to Define, Modify, or Create a report. The report utilizes the data fields in the test Results files. Typical data may include an instruments Manufacturer and Serial Number as well as the Operator's Name, the Calibration Time, (elapsed and chronological) and other such data.

### Object and Source Code

Model 7411A Calibration-at-a-Keystroke software and the optional 7411A-001 Calibration History Management software are provided as object code. Their provision is subject to the signing of a Software Licensing agreement.

Source Code for both Model 7411A and 7411A-001 is available as 7411A-100 and 7411A-101, respectively. The provision of source code is also subject to the signing of a Software Licensing agreement.

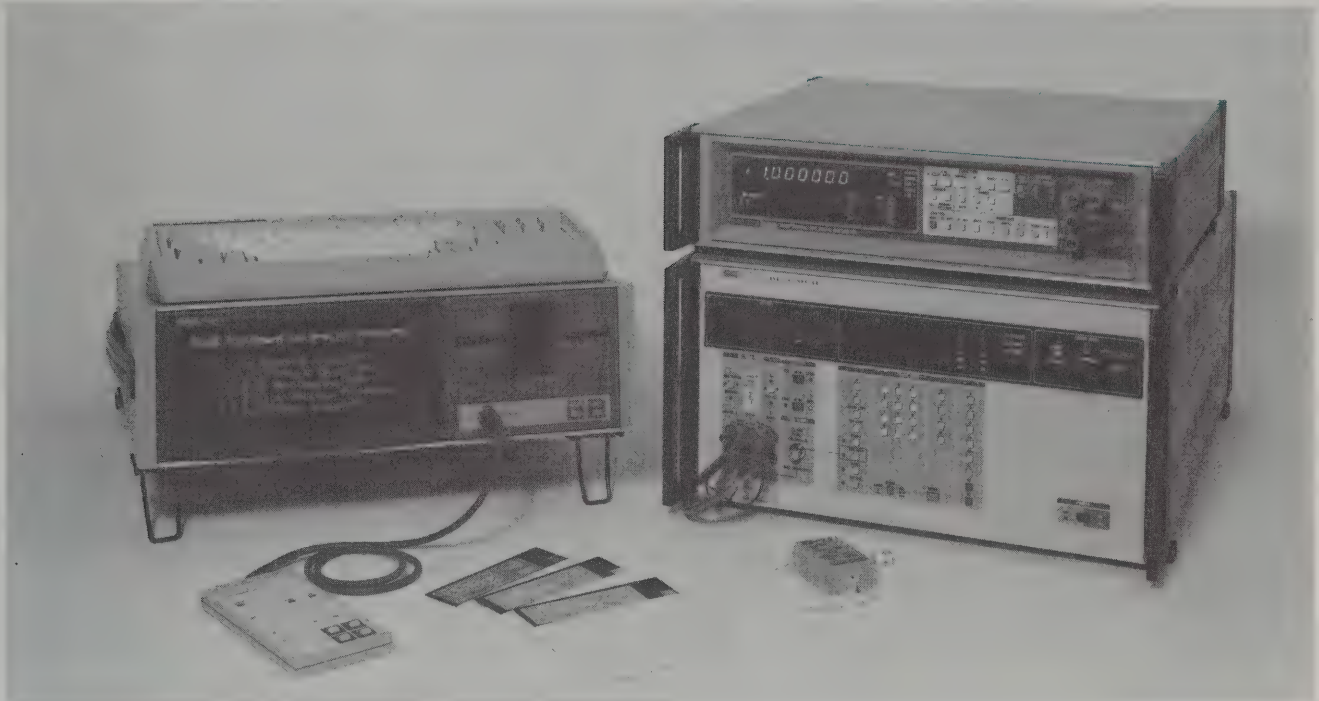
### Models

#### January 1985 Licensing Fees

7411A Calibration-at-a-Keystroke software .....	\$4000
7411A-001 Calibration History Management software .....	500
7411A-100 Source Code for Model 7411A .....	5000
7411A-101 Source Code for Model 7411A-001 .....	1000

# COMPUTER-AIDED CALIBRATION

## Benchtop Cluster 7404B



7404B

### 7404B Computer-Aided Benchtop Cluster

- Automated five function calibration with measurement
- Highly accurate
- Easy to operate
- Automatic recording of test results
- Calibration report generation software standard
- Convenient benchtop operation

The new Fluke 7404B is an automated, highly accurate meter calibration benchtop cluster. The 7404B allows you to quickly perform more accurate calibrations of digital and analog meters, power supplies, and other electronic instruments.

The 7404B combines Fluke field-proven hardware with state-of-the-art software all designed for reliability, durability, and performance to meet your most stringent demands. Hardware combines the Fluke 5100B Multifunction Calibrator with the Fluke 8506A Digital Multimeter under the automated control of the Fluke 1722A Instrument Controller.

The Fluke 5100B Calibrator, the world's best selling calibrator, gives you six function capability in a single instrument. You get direct and alternating volts, direct and alternating current, resistance, and rf (optional). Five of these sources are available from a single output. The operator does not need to spend time moving connections and switching a test interface panel.

The 7404B is more than merely a computer-aided calibration benchtop cluster with six function sourcing capability along with the measurement capability of one of the world's most accurate digital multimeters. Far more than this, synergistic design gives you "accuracy enhancement." The 7404B utilizes the inherent accuracy of the 8506A Digital Multimeter to increase the accuracy of the 5100B Calibrator, giving you more accurate calibrations. Resolution of 7½ digits and accuracy of 5 ppm (dV) make the 8506A an outstanding calibration reference instrument.

Thanks to accuracy enhancement, the 7404B gives you a basic direct volts uncertainty spec of 16 ppm and alternating volts to 0.016%. This enhancement process is accomplished automatically via software. It does not mean extra work for the operator.

Benchtop cluster automation is given by the Fluke 1722A Instrument Controller. The 1722A is a true instrument controller, not a personal computer. The 1722A was designed to control instruments over the IEEE-488 bus so you get the best possible performance in your computer-aided calibration system.

With the Fluke 1722A, software overhead is minimized giving you the fastest computer-aided calibration system on the market today. The Fluke 1722A features extremely high speed performance using a 24 MHz clock to achieve an instruction cycle rate of 6 MHz. The operator does not wait for the computer, the computer waits for the operator. Compare it to other systems on the market and see for yourself.

Fluke has given the utmost attention to designing an easy to use benchtop cluster with convenient operator interface. While using the cluster in calibration, the operator interacts via the Touch Sensitive Overlay. Instructions are displayed to the operator on the screen and obvious options are presented. The operator makes his selection by touching the screen. If the operator prefers, he may simply sit back and make his selections on a handheld keypad. He does not need to worry about typing in commands on a keyboard.

### User-Configured 7404B Benchtop Clusters

The 7404B has been modularly designed to give you maximum flexibility in configuring the benchtop cluster. The total 7404B instrument group and software may be purchased as the 7404B. Or, for those who already have one or more of the instruments, the 7404B can be customer configured by ordering the necessary options from the option list below. For example, if you already have the 5100B with an IEEE-488 interface, you may configure the 7404B simply by ordering the 7400A-506, the 7400A-993, and the 7404B-800 to give you the fully configured 8506A, 1722A, and software package with accessories.



# COMPUTER-AIDED CALIBRATION

## Benchtop Cluster 7404B

### Specifications

**Direct Volts:** (% of Output + Microvolts)

**Output Voltage:** Uncertainty

Range	Uncertainty	
	90 Days	180 Days
0 mV to 200 mV	.0020 + 2.8	.0025 + 5.3
200 mV to 2V	.0012 + 8	.0018 + 8.3
2V to 20V	.0008 + 80	.0011 + 83
20V to 128V	.0015 + 600	.0018 + 630
128V to 1100V	.0015 + 6000	.0018 + 6300

**Alternating Volts:** (% of Output & Microvolts)

**Output Voltage:** Uncertainty, 90 days

Range	Frequency		
	10 Hz to 40 Hz	40 Hz to 20 kHz	20 kHz to 50 kHz
12.5 mV to 125 mV	.08 + 0	.026 + 5	.06 + 0
125 mV to 400 mV	.08 + 0	.016 + 0	.06 + 0
400 mV to 1.25V	.08 + 0	.016 + 0	.06 + 0
1.25V to 4V	.08 + 0	.016 + 0	.06 + 0
4V to 12.5V	.08 + 0	.016 + 0	.06 + 0
12.5V to 20V	.08 + 0	.016 + 0	.06 + 0
20V to 110V	.08 + 0	.016 + 0	—
110V to 600V	—	.016 + 0*	—

\*50 Hz to 1 kHz

**Output Voltage:** Uncertainty, 180 days

Range	Frequency		
	10 Hz to 40 Hz	40 Hz to 20 kHz	20 kHz to 50 kHz
12.5 mV to 125 mV	.104 + 0	.029 + 5	.068 + 0
125 mV to 400 mV	.104 + 0	.019 + 0	.068 + 0
400 mV to 1.25V	.104 + 0	.019 + 0	.068 + 0
1.25V to 4V	.104 + 0	.019 + 0	.068 + 0
4V to 12.5V	.104 + 0	.019 + 0	.068 + 0
12.5V to 20V	.104 + 0	.019 + 0	.068 + 0
20V to 110V	.104 + 0	.019 + 0	—
110V to 600V	—	.019 + 0*	—

\*50 Hz to 1 kHz

**Direct Current:**  $\pm(0.018\% \text{ of setting} + 0.0018\% \text{ of range} + 0.01 \mu\text{A})$   
**Alternating Current:**  $\pm(0.05\% \text{ of setting} + 0.008\% \text{ of range} + 2 \mu\text{A})$

**Resistance Uncertainty**

1 $\Omega$	$\pm 0.015\%$
10 $\Omega$	$\pm 0.0075\%$
100 $\Omega$	$\pm 0.005\%$
1 k $\Omega$	$\pm 0.005\%$
10 k $\Omega$	$\pm 0.005\%$
100 k $\Omega$	$\pm 0.005\%$
1 M $\Omega$	$\pm 0.01\%$
10 M $\Omega$	$\pm 0.05\%$

### Option Descriptions

**7400A-506:** Fully configured 8506A Digital Multimeter.

**7404B-800:** 7404B software package including operator's aid, 1000:1 AC Divider, two cables for interfacing to IEEE-488 bus, accuracy enhancement cabling, and instruction manual.

**7404A-970:** 5100B Calibrator including Option -03 and -05.

**7400A-993:** 1722A Instrument Controller including 512K byte RAM and additional IEEE-488/RS-232-C Interface.

**7400A-300:** 1776B Printer with stand and paper, IEEE-488 compatible.

**7404B-600:** Additional manual.

### Model

January 1985 prices

**7404B Benchtop Cluster** ..... \$29,950

### Options

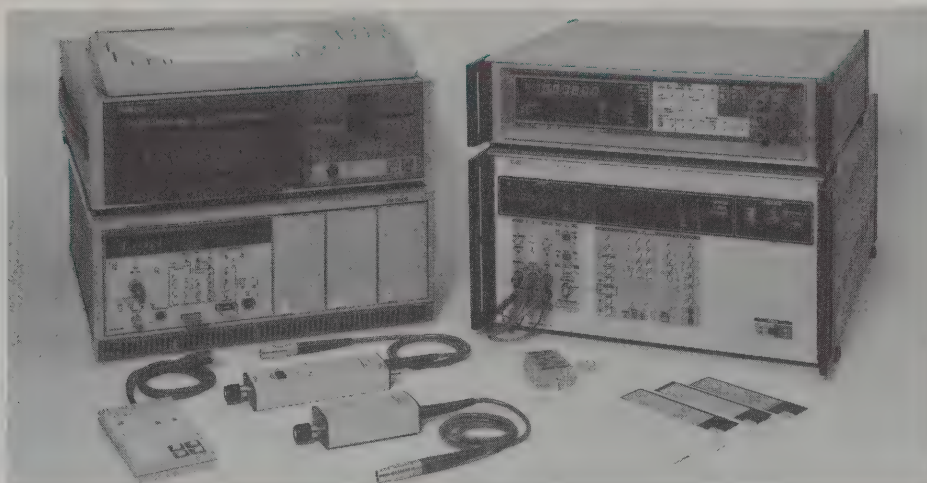
**7400A-506** 8506A DMM w/options ..... 6340  
**7404B-800** 7404B Software Package ..... 5295  
**7404A-970** 5100B Calibrator w/options ..... 13,875  
**7400A-993** 1722A Controller w/options ..... 10,290  
**7400A-300** Printer w/stand ..... 2295  
**7404B-600** Additional manual ..... 100

### After-Warranty Service (See page 227)

**SC1-7404B** ..... 1852

# COMPUTER-AIDED CALIBRATION

## Benchtop Cluster 7449A

**NEW**


7449A

### 7449A Computer-Aided Benchtop Cluster

- Automated meter and oscilloscope calibration
- Durable instrumentation and reliable software
- Easy operation with benchtop convenience
- Better personnel management with reduced training time
- Automatic recording of test results
- Calibration report generation software standard

The new Fluke 7449A adds oscilloscope calibration capability to the already impressive line up of capabilities of the Fluke 7404B Benchtop Cluster. With the 7449A you get calibration and verification capability of oscilloscope vertical gain, horizontal timing and gain, vertical pulse characteristics, probe accuracy and compensation, current probe accuracy, and calibrator output accuracy along with six function meter calibration and measurement.

In the 7449A durable instrumentation joins reliable software to give you combined meter/oscilloscope calibration on which you can depend. With the 7449A you can address your growing meter and oscilloscope calibration needs with one computer-aided calibration benchtop cluster.

The Fluke 7449A gives you the Fluke 5100B Multifunction Calibrator, the Fluke 8506A DMM for measurement and accuracy enhancement, and the Tektronix CG5001 Oscilloscope Calibrator, all controlled via IEEE-488 bus by the Fluke 1722A Instrument Controller.

The 7449A gives you six function meter calibration with a basic direct voltage uncertainty of 16 ppm and alternating voltage uncertainty to 0.016%. Plus, for oscilloscope calibration you get voltage output amplitude from 40  $\mu$ V to 200V, time markers from 400 ps to 5s, a risetime less than 200 pS, square wave amplitude accuracy of 0.25%, and measurement capability.

All this capability is controlled by the Fluke 1722A Instrument Controller featuring the touch sensitive display. Extremely fast command execution, advanced instrument control capabilities, and expansive memory give the 1722A important advantages over personal computers as the "brain" of your computer-aided benchtop cluster.

The 7449A has been designed to be very easy to use. With the 7449A you can get good calibration results from operators with little calibration experience. Instructions are presented on the screen of the 1722A, operators make their choices via the touch sensitive display or via the convenient operator's aid, and results are automatically recorded.

### User-Configured 7449A Benchtop Clusters

The 7449A has been modularly designed to give you maximum

flexibility in configuring the system. The total 7449A instrument group and software may be purchased as the 7449A. Or, for those who already have one or more of the instruments, the 7449A can be customer configured by ordering the necessary options from the option list below. For example, if you already have the 5100B with IEEE interface, you may configure the 7449A simply by ordering the 7409A-400, the 7400A-506, the 7400A-993, and the 7449A-800 to give you the fully configured CG5001, 8506A, 1722A, and software package with accessories.

### Specifications

Specifications for the 7449A are the same as the specifications for the 7404B combined with the stimulus specifications for the basic 7410A.

### Option Descriptions

**7409A-400:** Tektronix CG5001 Calibrator with TM5006 mainframe, pulse head, and comparator head.

**7400A-506:** Fully configured 8506A Digital Multimeter.

**7449A-800:** 7449A software package including operator's aid, 1000:1 ac divider, three cables for interfacing to IEEE-488 bus, accuracy enhancement cabling, and instruction manual

**7404A-970:** 5100B Calibrator including Option -05.

**7400A-993:** 1722A Instrument Controller including 512K byte RAM.

**7400A-300:** 1776B Printer with stand and paper, IEEE-488 compatible.

**7449A-600:** Additional manual.

### Model

January 1985 prices

7449A Benchtop Cluster ..... on req.

### Options

7409A-400 CG5001 Calibrator, w/pulse, comparator .....	22,500
7400A-506 8506A DMM w/options .....	6340
7449A-800 7449A Software Package .....	5380
7404A-970 5100B Calibrator w/option .....	13,875
7400A-993 1722A Controller w/option .....	10,290
7400A-300 Printer w/stand .....	2295
7404B-600 Additional manual .....	100

### After-Warranty Service (See page 227)

SC1-7449A ..... 1852

### On-Site Service

See page 227 for more information.



# COMPUTER-AIDED CALIBRATION

## 7405A Multimeter Calibration System



7405A

### 7405A Multimeter Calibration System

- Allows efficient use of technical personnel
- Simplifies and speeds the calibration process
- Automatic results recording
- Guarantees repeatability of calibration events
- System synergism provides accuracy enhancement
- Provides variable resistance
- Complete data management package

The 7405A is a fully automated, precision calibration workstation. It can rapidly and accurately calibrate a wide range of meters including DMMs, DVMs, VTVMs, and VOMs as well as voltage and current sources, power supplies, amplifiers, and passive devices.

A basic 7405A is comprised of a fully integrated group of Fluke measurement and calibration instruments — the 5100B Calibrator, the 8505A Digital Multimeter, and the 1722A Instrument Controller — built into a console having a single unique Test Interface Panel. Switching circuitry in the test panel provides functional self tests. Innovative software combined with the test panel enhances the 7405A accuracy (e.g., 20 ppm for dc, 0.025% for ac) making 7405A specifications exceed those of the stand-alone instruments.

The 7405A software package offers clear advantages over other automated calibration systems. For one thing, experienced programmers are not needed. Calibration procedures can be written without learning any computer language. The 7405A accepts instructions using calibration terminology that calibration people know. Automated test procedures which formerly took specialists

several days to write can now be produced in less than an hour. The 7405A software package represents a ten-man-year effort for Fluke. We made this investment so you don't need to develop your own application software. In less than half of a day, you should be able to install, run, test, and verify a new 7405A Workstation.

The brain of the 7405A is the Fluke 1722A Instrument Controller, designed specifically to control test and measurement instrumentation.

Ease of procedure writing and operation are key features of the 1722A in a 7405A. Procedures are entered into the controller's memory via a detachable, full ASCII keyboard. Operators use either the touch-sensitive CRT display or a handheld Operator's Aid. It's impossible for an operator to inadvertently alter a test procedure when the keyboard is detached. The operator is guided through each test quickly by messages that appear on the CRT screen. Results-data are stored automatically, eliminating the need for tedious and time-consuming manual record keeping. And, because the 7405A is both fast and thorough, there is no tradeoff between speed and quality or accuracy.

Test equipment is a valuable resource. Costly delays occur when it is in the calibration "pipeline". With a 7405A, your instruments can be recalled, adjusted, verified, documented, and returned all in the same day.

The 7405A uses field-proven instrumentation and includes a Functional Self-Test program to help trace faults quickly and easily. Also, your Fluke Technical Center can offer several maintenance plans to meet your special needs.

The 7405A lowers labor costs by more efficient use of your most valuable technical personnel. Labor savings alone can often justify the purchase of a 7405A.

# COMPUTER-AIDED CALIBRATION

## 7405A Multimeter Calibration System

### Specifications

Except where noted, the following specifications apply for 90 days when operating in an ambient temperature of 18°C to 28°C, in a relative humidity of 70% or less, and when the line voltage is within  $\pm 10\%$  of the nominal value for the system (100V ac, 120V ac, or 230V ac), 50 to 60 Hz. One-hour warmup required for basic accuracy; three-hours for enhanced accuracy. Accuracy is enhanced using a combination of system hardware and software.

#### DC Voltage Source

##### Accuracy and Resolution

Output	Accuracy: $\pm$ (% of Output + Floor)		Resolution
	Basic	Enhanced	
0V to 20 mV	0.005% + 7 $\mu$ V	—	100 nV
20 mV to 200 mV	0.005% + 9 $\mu$ V	0.003% + 6 $\mu$ V	1 $\mu$ V
200 mV to 2V	0.005% + 27 $\mu$ V	0.002% + 8 $\mu$ V	10 $\mu$ V
0 to 2V*	0.005% + 200 $\mu$ V	0.001% + 80 $\mu$ V	100 $\mu$ V
2V to 20V	0.005% + 200 $\mu$ V	0.001% + 80 $\mu$ V	100 $\mu$ V
20V to 160V	0.005% + 2 mV	0.002% + 800 $\mu$ V	1 mV
160V to 700V	0.005% + 11 mV	0.002% + 8 mV	10 mV
0V to 1100V**	0.06% + 20 mV	0.015% + 8 mV	10 mV

\*50 $\Omega$  Override mode

\*\*With voltage boost (Option -100), enhanced 20V-1100V only

#### AC Voltage Source

**Frequency Range:** 50 Hz to 50 kHz; 10 Hz to 10 MHz in wideband mode  
**Frequencies Selectable:** 10 Hz steps to 100 Hz; 100 Hz steps to 1 kHz; 1 kHz steps to 10 kHz; 10 kHz steps to 100 kHz; 100 kHz steps to 1 MHz; 1 MHz steps to 10 MHz

**Frequency Accuracy:**  $\pm 3\%$  of selected value

**Voltage vs Frequency:**  $\leq 110$  V to 50 kHz or less;  $\leq 500$  V to 1 kHz or less. With voltage boost (Option -100)  $\leq 1100$  V to 50 kHz or less

#### Voltage Accuracy

Range	$\pm$ (% of Output + Floor)			
	Basic		Enhanced*	
	50 Hz to 10 kHz 0.05%+	10 kHz to 50 kHz 0.08%+	100 Hz to 5 kHz (1) 0.015%+	50 Hz - 100 Hz 5 kHz - 10 kHz (2) 0.03%+
20 mV	50 $\mu$ V	50 $\mu$ V	—	—
200 mV	60 $\mu$ V	66 $\mu$ V	—	—
2V	150 $\mu$ V	210 $\mu$ V	100 $\mu$ V	100 $\mu$ V
20V	12 mV	1.6 mV	1 mV	1 mV
200V	10 mV	16 mV	10 mV	10 mV
500V	55 mV	—	100 mV	100 mV
1100V (3)	0.08% + 100 mV	0.12% + 150 mV	0.04% + 100 mV	0.055% + 100 mV

\*With temperature stable within  $\pm 3^\circ\text{C}$

(1) 1 kHz for 1100V range

(2) 50 Hz to 100 Hz only in 1100V range

(3) With voltage boost (Option -100)

#### AC Voltage Divider Mode

RMS Output	Accuracy $\pm$ (% of Output + Floor)	Resolution
100 $\mu$ V to 200 $\mu$ V	0.5% + floor, * 50 Hz to 50 kHz	1 nV
200 mV to 2V	0.25% + floor, * 50 Hz to 10 kHz 0.3% + floor, * 10 kHz to 50 kHz	10 nV
2V to 20V	Same as for 200 mV to 2V output	100 nV

\* Floor can be less than 1  $\mu$ V when proper means are taken to minimize ground current errors.

**Maximum Load:** 1 M $\Omega$ , 100 pF (50 $\Omega$  output impedance)

#### Wideband Mode\*

RMS Output	Accuracy	Flatness Over Range			
	at 1 kHz $\pm$ (% of Output + Floor)	Hz		MHz	
		10	30	1	5 10
300 $\mu$ V to 1 mV	2.00+2.5 $\mu$ V				
1 mV to 3.1623 mV	1.75+8 $\mu$ V				
3.1624 mV to 10 mV	1.50+25 $\mu$ V				
10 mV to 31.623 mV	1.25+80 $\mu$ V	$\pm 0.3\%$	$\pm 0.25\%$	$\pm 0.6\%$	
31.624 mV to 100 mV	1.00+250 $\mu$ V				
0.1V to 0.31623V	0.75+0.8 mV				
0.31624 to 1V	0.50+2.5 mV				
1V to 3.1623V	0.25+8 mV				

\* Using the 18 inch 50 $\Omega$  coaxial cable and precision termination supplied

**Resolution:** 5 ppm

**Harmonics:** -40 dB or lower, relative to fundamental to 5 MHz; -32 dB above 5 MHz

**Spurious Outputs:** -50 dB or lower, relative to fundamental

#### DC Current Source

Range	Accuracy $\pm$ (% of Output + Floor)	Resolution	Compliance Voltage
10 $\mu$ A to 200 $\mu$ A	0.025+0.015 $\mu$ A	1 nA	
0.2 mA to 2 mA	0.025+0.06 $\mu$ A	10 nA	
2 mA to 20 mA	0.025+0.5 $\mu$ A	100 nA	$\geq 10$ V*
20 mA to 200 mA	0.025+5 $\mu$ A	1 $\mu$ A	
0.2A to 2A	0.025+50 $\mu$ A	10 $\mu$ A	$\geq 2$ V*
1A to 10A(1)	0.025+1 mA	100 $\mu$ A	$\geq 3.8$ V
10A to 20 A(2)			$\geq 3.6$ V

\* For compliance voltage greater than 1 V, add 0.002% of output per volt

(1) With current boost (Option -120)

(2) Up to 10A can be supplied continuously; 20A for 1 minute

#### AC Current Source (50 Hz to 1 kHz)

Range	Accuracy $\pm$ (% of Input+Floor)	Resolution	Compliance Voltage
10 $\mu$ A to 200 $\mu$ A	0.07+40 $\mu$ A	1 nA	
0.2 mA to 2 mA	0.07+220 nA	10 nA	$\geq 7$ V rms*
2 mA to 20 mA	0.07+2 $\mu$ A	100 nA	
20 mA to 200 mA	0.07+20 $\mu$ A	1 $\mu$ A	
0.2A to 2A	0.07+200 $\mu$ A	10 $\mu$ A	$\geq 1.3$ V rms*
1A to 10A(1)	0.07+1 mA	100 $\mu$ A	$\geq 2.8$ V rms
10A to 20 A(2)			$\geq 2.6$ V rms

\* Add 0.4 nA per millivolt of compliance voltage up to 1 V. Above 1 V add (0.005% of output + 20 nA) per volt

(1) With current boost (Option -120)

(2) Up to 10A can be supplied continuously; 20A for 1 minute.

#### Resistance, Fixed Values, Basic

Values	Accuracy	Maximum Power	Power Coefficient
1 $\Omega$	0.02%	1W	0.1 ppm/mW
10 $\Omega$	0.01%		0.3 ppm/mW
100 $\Omega$ 1 k $\Omega$ 10 k $\Omega$ 100 k $\Omega$	0.005%		
1 M $\Omega$	0.01%	100 mW	0.2 ppm/mW
10 M $\Omega$	0.05%	10 mW	0.02 ppm/mW



# COMPUTER-AIDED CALIBRATION

## 7405A Multimeter Calibration System

### Resistance, Fixed Values, Enhanced

Values	Accuracy			Power Coefficient*
	24 Hours	90 Days, 18°C to 28°C		
	23°C ±1°C	Δ±3°C	—	
1.9Ω	0.1%	0.1%	0.15%	2 ppm/mW 1 ppm/mW
19Ω	0.016%	0.02%	0.03%	
190Ω	0.0040%	0.005%	0.01%	
1.9 kΩ				
19 kΩ	0.0035%	0.005%	0.009%	0.7 ppm/mW
190 kΩ				
1.9 MΩ	0.005%	0.007%	0.02%	1 ppm/mW
19 MΩ	0.017%	0.03%	0.05%	12 ppm/mW

\* Maximum power is 1.5W for 19 MΩ, 1W for 1.9 MΩ and 0.5W for all other values.

### Variable Values, Enhanced

"Variable Resistance" utilizes an active technique to simulate resistance and conductance sources. The specifications stated were derived using a typical multimeter, such as the Fluke 8600A, or Fluke 8800A, which is non-autoranging and has a short-term stability of better than 20 ppm. These specifications may vary for other meters.

Range	Accuracy, 18°C to 28°C after a Warm-up of:		Resolution
	3 Hrs, Δ3°C	1 Hour	
1Ω to 20Ω	0.021%+0.8 mΩ	0.031%+0.8 mΩ	100 μΩ
20Ω to 200Ω	0.004%+8 mΩ	0.008%+8 mΩ	1 mΩ
200Ω to 2 kΩ	0.0055%+10 mΩ	0.0095%+10 mΩ	10 mΩ
2 kΩ to 20 kΩ	0.0055%+100 mΩ	0.0095%+100 mΩ	100 mΩ
20 kΩ to 200 kΩ	0.0055%+1Ω	0.0095%+1Ω	1Ω
200 kΩ to 2 MΩ	0.0075%+10Ω	0.022%+10Ω	10Ω
2 MΩ to 20 MΩ	0.026%+1.8 kΩ	0.042%+2 kΩ	100Ω

## Measurement Specifications

### DC Voltage Measurements

Input Resistance: >10,000 MΩ for ≤20V full scale; 10 MΩ for 700V or 160V full scale; 1 MΩ, for 1100V full scale

### Accuracy and Resolution:

Full Scale	Accuracy ±(% of Input+Floor)		Resolution
	24 Hours	90 Days	
	23°C ±1°C	18°C to 28°C	
312 mV	0.002+5 μV	0.003+5 μV	1 μV
2.5V	0.001+6 μV	0.002+8 μV	
20V	0.001 or 60 μV*	0.001+ 80 μV	10 μV
160V	0.001+600 μV	0.002+800 μV	100 μV
700V	0.001+6 mV	0.002+8 mV	1 mV
1100V	0.014+6 mV	0.0015+8 mV	

\*Whichever is greater.

### Resistance Measurements

#### Accuracy and Resolution

Full Scale	Accuracy ±(% of Input+Floor)		Resolution
	24 Hours	90 Days	
	23°C ±1°C	18°C to 28°C	
31.25Ω	0.003+2 mΩ	0.005+2 mΩ	100 μΩ
250Ω	0.002+1.4 mΩ	0.003+1.4 mΩ	100 μΩ
2 kΩ	0.002+8 mΩ	0.003+8 mΩ	1 mΩ
32 kΩ	0.002+80 mΩ	0.003+80 mΩ	10 mΩ
256 kΩ	0.002+800 mΩ	0.003+800 mΩ	100 mΩ
4.096 MΩ	0.003+8Ω	0.004+8Ω	1Ω
32.768 MΩ	0.02+80Ω	0.03+80Ω	10Ω
262.144 MΩ	0.13+800Ω	0.15+800Ω	100Ω

### AC Voltage Measurements (True RMS)

Voltage Ranges	Full Scale	Resolution	Input Impedance
1V	2.5V	1 μV	1 MΩ, <200 pF
10V	20V	10 μV	
100V	160V	100 μV	
500V	500V	1 mV	
1000V	1100V	1 mV	1 MΩ, <100 pF

Frequency: Dc to 300 kHz, 2 x 10<sup>7</sup> maximum volt-hertz product 1 kHz or less above 500V. Slow filter must be used for full accuracy below 400 Hz

### Accuracy (AC + DC Mode)

Input Voltage Range	±(% of Input+Floor), 18°C to 28°C		
	Basic	Enhanced, Δ±3°C Max	
	50 Hz to 10 kHz	50 Hz to 100 Hz 5 kHz to 10 kHz	100 Hz to 5 kHz
0.2V to 2.5V	0.1+750 μV	0.03+100 μV	0.015+100 μV
2.5V to 20V	0.1+6 mV	0.03+1 mV	0.015+1 mV
20V to 160V	0.1+48 mV	0.03+10 mV	0.015+10 mV
160V to 500V	0.1+150 mV	0.03+100 mV	0.015+100 mV
500V to 1100V	0.125+300 mV	0.055+100 mV	900.04+100 mV

### Wide Range Accuracy\*

Frequency Range	Input	Plus % of Full Scale	
		AC	AC + DC
DC	0.1	—	0.03
10 Hz to 20 Hz	1.0	0.04	0.06
20 Hz to 50 Hz	0.5	0.012	0.03
50 Hz to 10 kHz	0.1	0.012	0.03
10 kHz to 30 kHz	0.2	0.04	0.06
30 kHz to 50 kHz	0.3	0.1	0.12
50 kHz to 100 kHz	1.0	0.3	0.3
100 kHz to 300 kHz	2.0	0.5	0.5

\* From 0.1% of range to full scale. Use 1000V as full scale for the 500V range and 2000V as full scale for 1000V range.

# COMPUTER-AIDED CALIBRATION

## 7405A Multimeter Calibration System

### DC Current Measurements

Current Range	Full Scale	Accuracy $\pm$ (% of Input +Floor)	Resolution	Burden Voltage
100 $\mu$ A 1 mA	312 $\mu$ A 2.5 mA	0.03+10 nA* 0.03+100 nA*	100 pA 1 nA	<100 mV
10 mA 100 mA	20 mA 160 mA	0.03+1 $\mu$ A* 0.05+20 $\mu$ A	10 nA 100 nA	<200 mV
1 A	1.28 A	0.05+200 $\mu$ A	1 $\mu$ A	<600 mV

\*Note: For source resistance ( $R_s$ ) less than—  
80 k $\Omega$  on 100  $\mu$ A range, accuracy floor is 9 (1+8000/ $R_s$ ) nA,  
10 k $\Omega$  on 1 mA range, accuracy floor is 90 (1+1000/ $R_s$ ) nA,  
1.25 k $\Omega$  on 10 mA range, accuracy floor is 0.9 (1+125/ $R_s$ )  $\mu$ A.

### AC Current Measurements

All ac current ranges, full scale values, resolution, burden voltage, and maximum current and voltage input values are the same as for dc current measurements.

**Accuracy:**  $\pm$ (% of Input+Floor)

Frequency Range	Current Range				
	100 $\mu$ A*	1 mA*	10 mA*	100 mA	1 A
10-20 Hz	1.0+110 nA	1.0+11 $\mu$ A	1.0+1.1 $\mu$ A	1.0+150 $\mu$ A	1.0+1.6 mA
20-50 Hz	0.8+35 nA	0.5+350 $\mu$ A	0.5+3.5 $\mu$ A	0.5+80 $\mu$ A	0.5+900 $\mu$ A
50 Hz to 10 kHz	0.4+35 nA	0.11+350 nA	0.11+3.5 $\mu$ A	0.26+80 $\mu$ A	0.26+900 $\mu$ A
10-20 kHz	1.0+110 nA	0.2+1.1 $\mu$ A	0.2+11 $\mu$ A	- -	- -
20-50 kHz	1.5+2.6 $\mu$ A	0.3+26 $\mu$ A	0.3+26 $\mu$ A	- -	- -
50-100 kHz	4.0+760 $\mu$ A	1.0+7.6 $\mu$ A	1.0+76 $\mu$ A	- -	- -

\* Accuracy limits given apply for the same minimum source resistance as for direct current.

### Option Specifications

#### Power Amplifier Option (-100)

Includes Fluke 5205A Power Amplifier for ac voltage to 1100 volts. Option -150 and Option -500 (or -501) are required; order separately. Integrated and tested as a system. For more information see 5205A pages in this catalog.

#### Transconductance Amplifier Option (-120)

Includes Fluke 5220A Transconductance Amplifier for current source to 20 amperes. Option -150 and Option -500 (or -501) are required, order separately. Integrated and tested as a system. For more information see 5220A pages in this catalog.

#### Interface Option (-150)

Includes Y5000 Interface accessory. Required for Option -100 and/or Option -120.

#### Counter/Timer Option (-200)

Includes Fluke 1953A Counter/Timer. Installed in standard cabinet and tested as a system.

#### Line Printer Option (-300)

Includes Fluke 1776A Line Printer, printer stand, paper tray, paper, and RS-232-C interface. An 80-column line printer able to print 200 lines per minute. For more information see 1776A pages in this catalog.

#### Rack Cabinet Option (-500)

Includes power distribution panel, rack adapters and slides for Options -100 and -120, cables for Options -150, and cooling ducts. Fully tested.

#### Rack Cabinet Option (-501)

Same as Option -500 except for 230V ac power lines, etc.

#### Work Station Option (-520)

Incorporates a large work surface, storage area, and a 1720A Instrument Controller mounting arm.

#### Additional Manual Set Option (-600)

One complete extra set of 7405A Manuals.

#### Intermediate Training Option (-700)

Includes five days of training at Fluke Park, Everett, Washington, U.S.A. Contact Fluke service for details.

### General Specifications

**Temperature:** +10°C to +40°C, operating; -10°C to +60°C, non-operating

**Relative Humidity:**  $\leq$ 70% from +18°C to +40°C

**Power Line:** 100V, 120V, or 230V ac  $\pm$ 10%, 50 Hz to 60 Hz

#### Power

**Standard Cabinet:** 500 VA fully loaded (including 1720A); 470 VA without 1953A (Option -200)

**Accessory Cabinet:** 1925 VA fully loaded; 325 VA without 5205A (Option -100); 1000 VA without 5220A (Option -120)

#### Size

**Standard or Accessory Cabinet:** 110 cm H x 61 cm W x 87.6 cm D (43.3 in x 24 in x 34.5 in)

**1722A Controller:** 14.6 cm H x 43.2 cm W x 62.2 cm D (5.25 in x 17 in x 20 in)

**Work Station:** 103 cm H x 81.3 cm W x 121 cm D (40.7 in x 32 in x 47.5 in). Table leaf is 61 cm wide (24 in)

#### Weight

**Standard Cabinet:** Approximately 186 kg (410 lb) fully loaded; 182 kg (401 lb) without 1953A (Option -200)

**Accessory Cabinet:** approximately 211 kg (465 lb) fully loaded; 157 kg (345 lb) without 5205A (Option -100); 188 kg (415 lb) without 5220A (Option -120)

**1722A Controller:** 17.4 kg (38 lb)

**Work Station:** Approximately 73 kg (161 lb)

### Model

January 1985 prices

7405A Automated Calibration Workstation ..... \$52,040

### Options

7405A-100 Power Amplifier (requires both -150 and -500 Options) .....	10,795
7405A-120 Transconductance Amplifier (requires both -150 and -500 Options) .....	5115
7405A-150 5100-Series Interface .....	585
7405A-200 Frequency Counter/Timer .....	2700
7405A-300 Printer .....	2295
7405A-500 Rack with Cabinet .....	3995
7405A-501 Same as -500, but 230V version .....	3995
7405A-520 Controller Work Station .....	1895
7405A-600 Additional Manual Set .....	395
7405A-700 One Week Training Course .....	950

### On-Site Service

See page 227 for more information.



# COMPUTER-AIDED CALIBRATION

## 7410A Automated Oscilloscope Calibration Workstation



7410A

### 7410A Automated Oscilloscope Calibration Workstation

- Efficient oscilloscope calibration
- Optimizes personnel management
- Expandable to meet your growing needs
- Automatic results recording
- Complete data management package

The Fluke 7410A is a fully integrated, automated calibration workstation which rapidly and accurately calibrates oscilloscopes of any manufacturer. It also verifies and calibrates plug-ins, probes, amplifiers, calibration fixtures, and related devices. The 7410A can be customized by the user to accommodate additional workloads.

The Fluke 7410A combines the powerful 1722A Instrument Controller with the Tektronix CG 5001 Programmable Calibration Generator. Other Fluke instrumentation provides additional measurement and stimulus capability to address the bulk of scope workload. Basic specifications include voltage output amplitude from 40  $\mu$ V to 200V, time markers from 400 ps to 5s, a risetime less than 200 ps, squarewave amplitude accuracy of 0.25%, and high voltage measurement capability. Optional sources add leveled sinewave testing in a 10 Hz to 1 GHz bandwidth.

The central 7410A Test Interface Panel guides the operator to the proper connection location. It also allows hardware expansion of the system with three user-defined ports.

Oscilloscope calibration no longer means using expensive and complex manual test equipment, operated by valuable skilled technicians. With the 7410A, the operator can typically increase

throughput 2 times while increasing repeatability. This improvement in quality and productivity results from the extensive, operator-oriented software package. Fluke combines calibration and systems experience to produce efficient, dependable oscilloscope calibration.

With traditional manual calibration methods, the cost per calibration remains constant as workload increases. However, the 7410A Automated Calibration Workstation lowers the cost per calibration. This savings results from expanded capability with the same personnel. Users with inventories of 300+ instruments find that the cost of calibration drops. And productivity increases as your workload increases. The labor savings associated with this improvement justify the purchase of a 7410A.

The expense of software development often turns knowledgeable managers away from automated systems. The 7410A software package represents the culmination of an extensive software development effort. With the 7410A you get software on which you can depend. Fluke also provides calibration procedures for scopes manufactured by Tektronix, Hewlett Packard, Philips, and others. Additional procedures can be generated by technicians.

7410A installation takes less than half a day. You can begin calibrating that same day. Because the 7410A automates the entire process (recall, procedure selection, verification, adjustment, and record keeping), it assures calibrations of the highest quality and lowest cost.

### Specifications

#### Voltage (Amplitude Mode)

The standard voltage is used to calibrate vertical display accuracy.

Range: 40  $\mu$ V to 200V (1-2-5 steps with multiplier)

# COMPUTER-AIDED CALIBRATION

## 7410A Automated Oscilloscope Calibration Workstation

**Multipliers:** 1, 2, 3, 4, 5, 6, 8, 10 divisions

**Polarity:** Positive from ground

**Accuracy:**  $\pm(0.25\% \pm 1 \mu\text{V})$

**Frequency:** DC or 10 Hz to 100 kHz (decade steps). 40 mV to 80 mV from 10 Hz to 100 kHz; 100 mV to 10V from 10 Hz to 100 kHz, or dc; 12V to 200V from 10 Hz to 10 kHz, or dc

**Variable Range:**  $\pm 9.9\%$

### Current (Amplitude Mode)

The standard current is used to calibrate current probes.

**Range:** 1 mA to 100 mA (1-2-5 sequence)

**Multipliers:** 1, 2, 3, 4, 5, 6, 8, 10

**Accuracy:**  $\pm(0.25\% \pm 2 \mu\text{A})$

**Frequency:** Dc or 10 Hz to 1 MHz (decade steps)

**Variable Range:**  $\pm 9.9\%$

### Edge (Amplitude Mode)

The low distortion pulses obtained in this mode are used to test oscilloscope input amplifier and attenuator compensation.

**Low Range:** 20 mV to 1V (1-2-5 steps with multipliers)

**Polarity:** Positive or negative transitions to ground

**Rise Time or Fall Time:**  $< 1.3 \text{ ns}$

**Aberrations:**  $\pm 2\%$

**Long Term Flatness:**  $\pm 0.5\%$  after first 10 ns

**Frequency:** 10 Hz to 1 MHz (decade steps)

**Variable Amplitude Range:**  $> \pm 10\%$  from nominal

**Termination:** 50 $\Omega$

**High Range:** 1.2V to 100V (1-2-5 steps with multipliers)

**Polarity:** Negative voltage, rising to ground

**Rise Time:**  $< 100 \text{ ns}$

**Aberrations:**  $\pm 2\%$

**Long Term Flatness:**  $\pm 0.5\%$  after first 500 ns

**Frequency:** 10 Hz to 100 kHz (decade steps)

**Variable Amplitude Range:**  $> \pm 10\%$  from nominal

**Termination:**  $\geq 1 \text{ M}\Omega$

### Markers (Timing Mode)

The markers obtained in this mode are used to calibrate oscilloscope time bases.

**Range:** 5s to 10 ns (1-2-5 steps)

**Accuracy:**  $\pm 0.01\%$

**Amplitude:** 1 volt minimum into 50 $\Omega$

**Variable Range:**  $\pm 9.9\%$

### Slewed Edge (Timing Mode)

Slewed edges are used to calibrate the very fastest ranges found on oscilloscope timebases.

**Range:** 100 ns to 0.4 ns (1-2-5 steps plus 0.4 ns)

**Accuracy:**  $\pm 0.01\%$

**Edge Position Uncertainty:**  $\pm 40 \text{ ps}$

**Amplitude:**  $> 1 \text{ V}$  into 50 $\Omega$

**Variable Range:**  $\pm 9.9\%$

### Trigger Output Rate

The oscilloscope under test may be triggered externally from this source. The output amplitude is 1 volt (minimum) into 50 $\Omega$ .

### Marker Mode

Normal: Slaved to marker rate from 5 s to 100 ns, remains at 100 ns for faster markers

Divided by 10: Reduces normal trigger rate by a factor of ten

Divided by 100: Reduces normal trigger rate by a factor of one hundred

**Slewed Edge Mode:** One trigger per slewed edge. (Rate divided by 10 and divided by 100 not available)

### All Other Modes

Normal: Slaved to output frequency

Divided by 10: One-tenth output frequency

Divided by 100: One-hundredth output frequency

### Pulse Head

The Pulse Head is used to generate fast-rise, low-distortion pulses for testing higher bandwidth vertical amplifiers.

**Amplitude:** 1.1 volt peak  $\pm 5\%$  into 50 $\Omega$

**Adjustable Range:**  $\pm 10\%$

**Rise Time:**  $\leq 200 \text{ ps}$

**Polarity:** Positive or negative from ground

**Aberrations:**  $\pm 3\%$  of pulse amplitude; not to exceed 4% peak-to-peak for adjacent peaks for zero to 50 ns

**Frequency:** 100 Hz to 100 kHz (decade steps)

### Comparator Head

The Comparator Head is used to calibrate built-in oscilloscope calibrators against the signals available from the system. Both the oscilloscope calibrator and CG 551AP standard amplitude signals are applied to the Comparator Head and simultaneously displayed on the oscilloscope CRT. The CG 551AP signals are then varied to obtain congruent displays.

### Input

AC Voltage:  $\pm 40 \mu\text{V}$  to  $\pm 100 \text{ V}$ , 10 Hz to 1 MHz—squarewave

DC Voltage: -100 mV to +100V

### Resistance

Open: Unterminated (the resistance of the oscilloscope input)

50 $\Omega$ : 50 $\Omega \pm 1\%$  in 50 $\Omega$  position. Maximum voltage is  $\pm 5 \text{ V}$  peak in the 50 $\Omega$  position

### Chop Parameters

Frequency: 30 Hz nominal. (Auto)

Auto Timeout: Internally selectable 0.5, 1 or 2 minutes

For complete specifications see Tektronix CG 5001 manual.

## Measurement Specifications

### DC Voltage Measurements

#### Input Characteristics

Range	Full Scale	Resolution	Input Resistance
100 mV	199.999	1 $\mu\text{V}$	$\geq 10,000 \text{ M}\Omega$
1V	1.99999	10 $\mu\text{V}$	$\geq 10,000 \text{ M}\Omega$
10V	16.0100	100 $\mu\text{V}$	$\geq 10,000 \text{ M}\Omega$
100V	130.100	1 mV	10 $\text{M}\Omega$
1000V*	1024.00	10 mV	10 $\text{M}\Omega$

\*To 6 kV with 80K-6 high voltage probe (included)

**Accuracy:**  $\pm(\% \text{ of Input} + \text{Digits})$

Range	24 Hours 23°C $\pm 1^\circ\text{C}$	90 Days 18°C to 28°C	1 Year 18°C to 28°C
100 mV	0.003 + 6	0.0065 + 7	0.011 + 11
1V	0.003 + 1	0.006 + 2	0.011 + 2
10V	0.002 + 1	0.005 + 1	0.009 + 1
100V	0.003 + 1	0.007 + 2	0.012 + 2
1000V	0.0035 + 1	0.0065 + 1	0.011 + 11

**Maximum Input:**  $\pm 1000 \text{ V}$  peak, HI to LO;  $\pm 20 \text{ V}$  peak GUARD to chassis terminal and GUARD to LO terminal, for any range

### High DC Voltage Measurements

Using an 80K-6 High Voltage Probe supplied with each 7410A, measurements of 1000V to 6000V dc may be made with an accuracy of  $\pm 1\%$ . The probe has an impedance of  $75 \text{ M}\Omega \pm 25 \text{ M}\Omega$ . Up to 40 kV may be measured using the optional 80K-40 probe.

### AC Voltage Measurements (True RMS)

Range	Full Scale	Resolution	Input Impedance
1V	1.99999	10 $\mu\text{V}$	1 $\text{M}\Omega$ , $\leq 290 \text{ pF}$ at the V/ $\Omega$ input terminal
10V	16.0100	100 $\mu\text{V}$	
100V	130.100	1 mV	
650V	650.000	10 mV	



# COMPUTER-AIDED CALIBRATION

## 7410A Automated Oscilloscope Calibration Workstation

Accuracy:  $\pm(\%$  of Input +  $\%$  of Full Scale)\*

Frequency	24 Hours 23°C $\pm 1^\circ\text{C}$			90 Days 23°C to 28°C			1 Year 18°C to 28°C		
	% of Input	+%FS AC	+%FS AC+DC	% of Input	+%FS AC	+%FS AC+DC	% of Input	+%FS AC	+%FS AC+DC
40 Hz to 20 kHz	0.08	0.02	0.06	0.1	0.03	0.08	0.15	0.05	0.16
20 kHz to 100 kHz	1.0	0.3	0.4	1.0	0.3	0.4	2.0	0.6	0.8
100 kHz to 300 kHz	2.4	0.6	0.6	2.4	0.6	0.6	4.0	1.0	1.0
300 kHz to 1 MHz	8.0	2.5	2.5	8.0	2.5	2.5	15.0	5.0	5.0

\* From 0.1% of range to full scale. For 650V range multiply percent of full scale by 1.6.

**Maximum Input:**  $\pm 1000\text{V}$  peak, HI to LO;  $\pm 20\text{V}$  peak GUARD to chassis terminal and GUARD to LO terminal, for any range

**Volt-Hertz Product:**  $\leq 2 \times 10^7$

**Slew Rate:**  $\leq 177\text{V}$  per microsecond

**Crest Factor:** Exceeds 4:1 at full scale, increasing downscale

### Resistance Measurements

#### Input Characteristics

Range	Full Scale	Resolution	Current Thru Unknown
10 $\Omega$	19.9999	100 $\mu\Omega$	10 mA
100 $\Omega$	199.999	1 m $\Omega$	10 mA
1000 $\Omega$	1999.99	10 m $\Omega$	1.0 mA
10 k $\Omega$	19.9999	100 m $\Omega$	0.1 mA
100 k $\Omega$	199.999	1 $\Omega$	14.5 $\mu\text{A}$ (max)
1 M $\Omega$	1.99999	10 $\Omega$	1.5 $\mu\text{A}$ (max)
10 M $\Omega$	19.999	1 k $\Omega$	1.5 $\mu\text{A}$ (max)
100 M $\Omega^*$	100 M $\Omega$	*	1.5 $\mu\text{A}$ (max)

\* Using Conductance mode

Accuracy:  $\pm(\%$  of Input + Digits)

Range	24 Hours 23°C $\pm 1^\circ\text{C}$	90 Days 18°C to 28°C	1 Year 18°C to 28°C
10 $\Omega$	0.0045 + 6	0.0080 + 7	0.0140 + 12
100 $\Omega$	0.0035 + 2	0.0070 + 2	0.0125 + 3
1000 $\Omega$	0.0035 + 2	0.0070 + 2	0.0125 + 3
10 k $\Omega$	0.0035 + 2	0.0070 + 2	0.0125 + 3
100 k $\Omega$	0.0040 + 2	0.0090 + 2	0.0140 + 3
1 M $\Omega$	0.0090 + 2	0.0160 + 2	0.0200 + 3
10 M $\Omega$	0.0300 + 1	0.0440 + 1	0.0450 + 3
100 M $\Omega^*$	0.0400 + 5	0.0500 + 5	0.0600 + 5

\* Using Conductance mode. When the instrument is operated in the 10 nS to 100 nS range the resolution is 0.001 nS. Therefore, if the reading is converted to ohms the resolution is 0.1 M $\Omega$  for a 100 M $\Omega$  reading and 0.001 M $\Omega$  for a 10 M $\Omega$  reading.

**Open Circuit Voltage:**  $< 8\text{V}$

**Maximum Input:**  $\pm 400\text{V}$  peak for any range

For complete specifications see Fluke 8520A Manual.

### Option Specifications

Includes Fluke 6011A Synthesized Signal Generator, installed and tested as a system.

#### Synthesized Signal Generator Option (-211)

**Frequency Ranges:** 10 Hz to 10.99999 MHz

**Frequency Resolution:** 10 Hz from 110 kHz to 11 MHz, 0.1 Hz from 10 Hz to 110 kHz

**Frequency Accuracy:**  $\pm 3$  ppm per year over temperature range of 0° to 50°C

**TCXO Aging Rate:** Less than 1 part in  $10^8$  per day at constant temperature, 1 part in  $10^6$  per year

**TCXO Temperature Dependence:** Less than  $\pm 2$  parts in  $10^6$  from 0° to 50°C ( $\pm 5$  parts in  $10^7$  optional, extra)

**Amplitude Range, dBm:** +26.98 dBm to -55.01 dBm, 50-ohm reference

**Amplitude Range, Volts:** 5.000V to 0.3972 mV rms into 50 ohm, 10.000V to 0.7944V rms open circuit

**Amplitude Resolution, dB:** 0.01 dB

**Output Impedance:** 50 ohms

**Temperature Stability:**  $\pm 0.2$  dB, 0°C to 50°C. Typical temperature coefficient is 0.

#### Synthesized Signal Generator Option (-270)

Includes Fluke 6070A Synthesized Signal Generator, installed and tested as a system.

**Frequency Range:** 200 kHz to 519.999999 MHz

**Frequency Resolution:** 1 Hz

**Frequency Accuracy:**  $\pm 5$  ppm from 0°C to 50°C ambient temperature

**Oscillator Aging Rate:**  $\pm 0.5$  ppm per month

**Amplitude Range:** +19 dBm to -140 dBm

**Amplitude Resolution:** 0.1 dB or 1% (voltage)

**Output Impedance:** 50 $\Omega$

**Amplitude Accuracy:**  $\pm 1.8$  dB from +19 to +13 dBm;  $\pm (1.1 \text{ dB} - 0.01 \text{ times dBm level})$  from +7 to -131 dBm;  $\pm 4.3$  dB from -131 to -141 dBm

**Amplitude Flatness:**  $\pm 0.55$  dB over entire range at 10 dBm

**Modulation:** Amplitude modulation, frequency modulation, and phase modulation capability available. See 6070A/6071A specification sheet for more details.

**Frequency Sweep:** Capability available. See 6070A/6071A specification sheet for more details.

**Modulation Signal Output:** 20 Hz to 200 kHz, 0V to 2V peak-to-peak into 600 $\Omega$

For more information see 6070A/6071A pages in this catalog.

Includes Fluke 6071A Synthesized Signal Generator, installed and tested as a system.

#### Synthesized Signal Generator Option (-271)

Includes Fluke 6071A Synthesized Signal Generator, installed and tested as a system.

**Frequency Range:** 200 kHz to 1039.999998 MHz

**Frequency Resolution:** 1 Hz to 520 MHz; 2 Hz above 520 MHz

**Amplitude Range:** +19 dBm to -140 dBm below 520 MHz; +13 dBm to -140 dBm above 520 MHz

**Amplitude Flatness:**  $\pm 0.65$  dB at 4 dBm

**Amplitude Accuracy:** Same as Option -270 below 520 MHz. Above 520 MHz:  $\pm 2.8$  dB from +13 to +7 dBm;  $\pm (1.9 \text{ dB} - 0.015 \text{ times dBm level})$  from +7 dBm to -131 dBm

**Other Specifications:** Same as for Option -270

For more information see 6070A/6071A pages in this catalog.

#### Line Printer Option (-300)

Includes Fluke 1776A Line Printer, printer stand, paper tray, paper, and RS-232-C Interface Cable, all tested as a system.

An 80-column line printer able to print 200 lines per minute. For more information see 1776A Printer pages in this catalog.

#### Workstation Option (-520)

Incorporates a large work surface, storage area, and a 1720A Instrument Controller mounting arm.

#### Additional Manual Set Option (-600)

One complete extra set of 7410A Manuals.

#### Intermediate Training Option (-700)

Includes five days of training at Fluke Park, Everett, Washington, U.S.A. Contact Fluke Service for details.

### General Specifications

**Temperature:** +10°C to +40°C, operating; -10°C to +60°C, non-operating

**Relative Humidity:**  $\leq 70\%$  from +18°C to +40°C

**Power Line:** 108V, to 127V ac or 216V to 254V ac, 50 Hz to 60 Hz

**Power:** 525 VA fully loaded, including 1720A, 6011A, and 6070A (or 6071A). 425 VA without 6011A. 400 VA without 6070A (or 6071A). 300 VA without 6011A, 6070A, or 6071A. For unit under test, 400 VA maximum.

# COMPUTER-AIDED CALIBRATION

## 7410A Automated Oscilloscope Calibration Workstation

### Size

**Standard Cabinet:** 110 cm H x 61 cm W x 87.6 cm D (43.3 in x 24 in x 34.5 in)

**1722A Controller:** 14.6 cm H x 43.2 cm W x 62.2 cm D (5.25 in x 17 in x 20 in)

**Workstation:** 103 cm H x 81.3 cm W x 121 cm D (40.7 in x 32 in x 47.5 in). Table leaf is 61 cm wide (24 in)

### Weight

**Standard Cabinet:** Approximately 163 kg (360 lb) fully loaded, including 6011A and 6070A (or 6071A) but excluding 1722A, Workstation, or 1776A Printer. Approximately 151.6 kg (335 lb) without 6011A. 135.3 kg (299 lb) without 6070A (or 6071A). 125 kg (274 lb) without 6011A, 6070A, or 6071A.

**1722A Controller:** 17.4 kg (38 lb)

**Workstation:** Approximately 73 kg (161 lb)

**1775A or 1776A Printer:** 29 kg (64 lb)

### Model

January 1985 Prices

**7410A Automated Calibration Workstation** ..... \$51,325

### Options

**7410A-211 w/6011A Signal Source** ..... 6000

**7410A-270 w/6070A Signal Source** ..... 6220

**7410A-271 w/6071A Signal Source** ..... 19,100

**7410A-300 w/1776A Printer** ..... 2295

### Accessories

**80K-40 High Voltage Probe** ..... 80

**Y1706 Pack of 10 Blank Disks** ..... 100

**Y1715 Additional box of printer paper** ..... 50

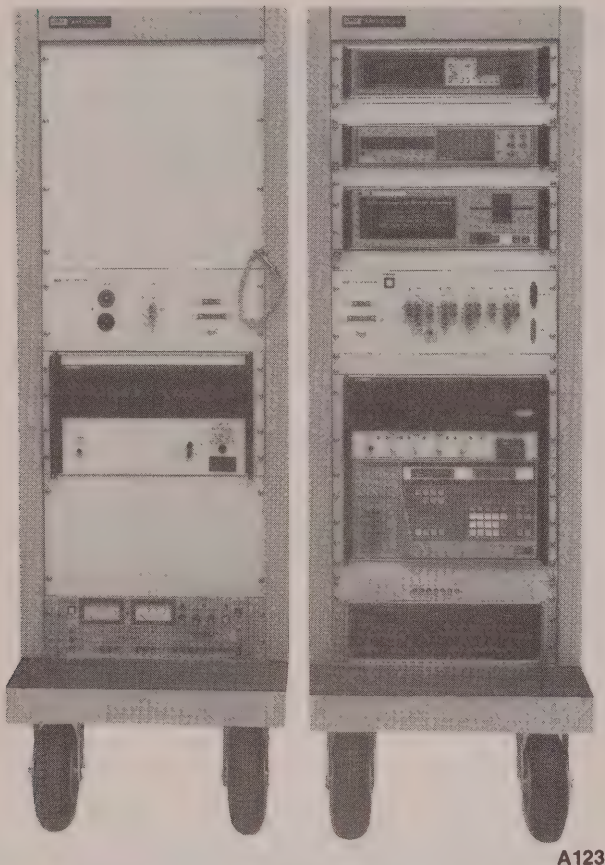
### On-Site Service

See page 227 for more information.



# COMPUTER-AIDED CALIBRATION

## Automated Workstations — Special



A123

### Special Automated Calibration Workstations

- Automated state-of-the-art accuracy
- Configurable to fit your calibration needs
- Combined meter/oscilloscope capability in one workstation
- Mobile automated calibration workstations

Flexibility is the key word for Fluke's new state-of-the-art special automated calibration workstations. Now you can select the instrument combinations you wish to automate to meet your calibration needs. Not only can you select from a wide array of both meter and oscilloscope calibration instruments, you can even select the rack in which you wish to have the instruments integrated. You may configure your workstation from customer furnished equipment, from all new equipment, or a combination of both.

These workstations include the A123, the world's most accurate 5½- and 6½-digit meter calibration workstation; the A144, a mobile meter calibration workstation dedicated to the calibration of meters such as the Fluke 8505A; and the 7405A/AC, a mobile version of the 7405A Automated Meter Calibration Workstation. However, you are not limited to these configurations alone. Fluke is very willing to configure arrangements of the instruments listed in the table on page 129. Merely contact your local Fluke Sales Office for help in configuring a workstation.

### The Fluke A123 — The World's Most Accurate Automated Meter Calibration Workstation

The Fluke A123 is a mobile automated calibration workstation, configured to calibrate 5½- and 6½-digit DMMs as well as a variety of other dl and LF test equipment. It features state-of-the-art accuracy for dV, aV, and Ohms stimulus, with dl, AI, and an electronic load also available.

The A123 automates Fluke Models 5440A, 5450A, 8505A, the 5200A/5215A, a transconductance amplifier and an electronic load. A Fluke 2205A is included in the workstation to switch drive voltages to the transconductance amplifier and electronic load.

The standard configuration is as in the above picture with two test interface panels (TIPs). The main TIP provides dedicated connectors for the 5440A, 5200A, 8505A, 5450A, and transconductance amplifier. It also contains connectors for the 1722A's IEEE-488 port 1 (for closed loop calibration via the IEEE-488 bus) and port 2 (for easy serial interface to a host computer). The auxiliary TIP provides connectors for the 5215A and electronic load.

### Variations

Variations of the A123 will be quoted by Fluke at your request. For example, the A123-4 provides all the A123 instruments in a single, fixed-bay rack with a 72-inch opening. A combined test interface panel is also provided with the A123-4, and the Fluke 1722A Instrument Controller is mounted on a Fluke Model 7400A-520 Controller Workstation. Fluke Model A123-5 provides a reduced complement of instruments in a shorter rack with the 1722A mounted on a modified version of the 7400A-520 Controller Workstation. Contact your Fluke Sales Engineer for more information about variations of the A123.

### The Fluke A144 — A "Cal Cart" for On-Site Accuracy

The Fluke A144 is a mobile automated calibration workstation configured to calibrate DMMs such as the Fluke Models 8505A or 8506A. This system includes the Fluke 5440A, the 5100B, the 8506A, and a Test Interface Panel, all controlled by the 1722A Instrument Controller. It has slightly less versatile and accurate aV and current capabilities than the A123.

The A144 configuration is especially handy for mobile uses such as rolling out onto a production floor for on-site calibration of system instruments.

### The Fluke 7405A/AC — The 7405A Goes Mobile

The Fluke Model 7405A/AC Mobile Automated Meter Calibration Workstation is a mobile version of the Fluke 7405A designed for easy calibration of production area system instruments. The 7405A/AC includes the 1722A, 8505A, 5100B, and Test Interface Panel with the 1953A Counter/Timer as an option. You also receive a work surface shelf, two storage drawers, and expansion area for possible inclusion of the 5220A.

The 7405A/AC ergonomics are optimized for applications where the operator is seated, but it is also convenient for standing operators. The equipment comprising the Fluke 7405A/AC is rack-mounted in a mobile enclosure on shock-mounted casters. The lower storage drawer may be used to store meter calibration accessories such as the Operators Aid and AC Divider, as well as loose equipment like test leads. The upper drawer can store the 1722A's keyboard and flexible diskettes. This drawer has a shelf top which can be used as a writing surface or a shelf on which to place the test instrument.

# COMPUTER-AIDED CALIBRATION

Automated Workstations — Special

## Complete Support

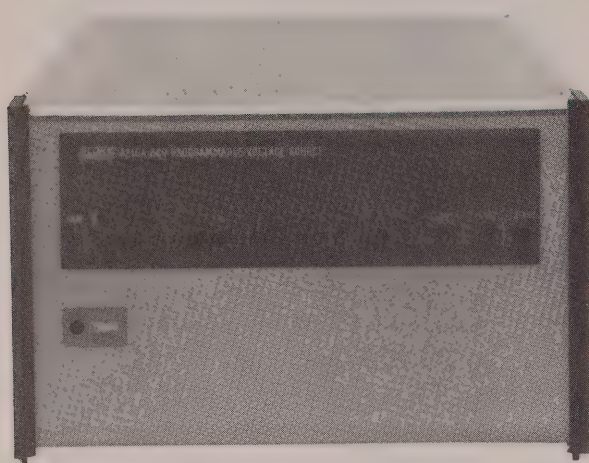
Fluke is the world leader in calibration instrumentation. This world leadership is reflected in the system support you receive when you purchase a Computer-Aided Calibration Workstation from Fluke. From the 7400 Series Users Group to training, to Service Support, you receive the best from Fluke.

- The Fluke Computer-Aided Calibration Users Group offers a means of communication among users who exchange calibration procedures or helpful hints on approaches to computer-aided calibration.
- Training is available through Fluke Service. Contact your local Fluke Service Center for quotes.
- Fluke offers the best service support in the calibration industry. Warranties are available along with service contracts which can even give you on-site repair.

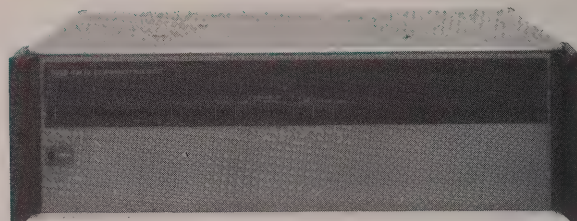


# PROGRAMMABLE POWER SUPPLIES

## 4200 Series



4210A, ½ Rack Width



4250A, Rack Width

### 4200 Series Power Supplies

- IEEE-488 or parallel interfaces
- BCD or binary 2s complement coding
- Isolated digital control of ac and dc external sources
- Up to 65V at 1 amp or 110V at ½ amp
- Fully guarded
- $\pm 0.01\%$  accuracy
- 100  $\mu\text{V}$  resolution capability
- 30 to 110  $\mu\text{s}$  response time

### 4200 Series Power Supplies

The 4200 Series Programmable Power Sources are more than just precision digital-to-analog converters. They incorporate features that are not available in typical programmable power supplies: speed, accuracy, low programming noise, true current limiting, isolated control logic, output proportional to an external reference voltage.

These power sources may be operated in series or parallel, just like batteries. They will operate with up to 1000 volts between chassis ground and guard (250 volts with IEEE-488 interface). That allows you to use them as a programmable vernier for high voltage power supplies. Current sink capability, coupled with programmable current limits, allows four of the six models to be used as a dynamic load.

### Isolated Control Logic Option (-01)

Isolated control logic is parallel BCD for the 4010A, 4250A, and 4270A and 14-bit or 16-bit parallel binary for the 4216A, 4265A, and 4275A and is available as Option -01. However, any of the six models may be ordered with multi-strobe logic (Option -09) or with an interface for compatibility with IEEE Std 488-1978 (Option -05).

### Multi-Strobe Logic Option (-09)

Allows programming directly from any 16-bit or 18-bit program source with addressing capabilities for up to eight 4200-Series Power Sources. The power sources may be in series as well as parallel. The control lines are electrically isolated from the output.

### IEEE-488 Compatibility Option (-05)

The IEEE-488 interface allows the user to program the following functions using command character format: Voltage, current limit, external reference, range, polarity, SRQ response on errors, operate and standby. In addition to the normal command string format of programming, the IEEE-488 interface offers a "Direct Ladder Access" mode of programming. This mode is a 4-byte transfer sequence with limited IEEE-488 error and syntax checking, but with fast output results. The repertoire is SH1, AH1, T6, L4, SR1, DC1, and DT1.

### External Reference Option (-03)

Output may be either polarity without reversing leads. In fact the output may be ac as well as dc. And, with Option -03, you have the ability to amplify or attenuate, by digital control, either an ac or dc voltage supplied by an external source. Output polarity matches input polarity. The 3 dB bandwidth is 100 kHz for the 4210A and 4216A, and 30 kHz for the other models.

### Current Limit Option (-06)

To protect devices being powered, the output current can be automatically limited to any value between 10% and 110% of maximum output current in 10% steps. Values less than 10% may be selected if an IEEE-488 interface version is purchased. Current is automatically limited at 120% of rated output when Option -06 is not installed.

### High Resolution Option (-07)

To be able to program output voltage with 10 times better resolution than normal, Option -07 may be ordered for models 4210A, 4250A, and 4270A. Option -06 cannot be installed at the same time, however.

### A4200 Manual Control Unit

For bench operation and calibration the A4200 is available as an accessory. It allows the operator to manually select each control line as well as monitor flag lines available from a power source. To view such characteristics as programming noise, settling time, rise time etc., an automatic mode is provided. When all the bits in any 8-4-2-1 decade are set, the power source will generate a staircase at the analog output which may be examined on an oscilloscope. The A4200 is not compatible with Option -09 or the IEEE-488 Interface Option (-05).

# PROGRAMMABLE POWER SUPPLIES

**4200 Series**

## Specifications

Characteristics	4210A	4250A	4270A	4265A	4275A	4216A
Display	BCD	BCD	BCD	Binary	Binary	Binary
Current Range	$\pm 100$ mA	$\pm 1$ A	$\pm 0.5$ A	$\pm 1$ A	$\pm 0.5$ A	$\pm 100$ mA
Option -06 Limit	—	10% steps*	10% steps*	10% steps*	10% steps*	—
Regulation <sup>1</sup>	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
Settling Time:						
Within 0.1% of step	18 $\mu$ s	70 $\mu$ s	80 $\mu$ s	70 $\mu$ s	85 $\mu$ s	18 $\mu$ s
Within 0.01% of step	30 $\mu$ s	100 $\mu$ s	110 $\mu$ s	100 $\mu$ s	110 $\mu$ s	30 $\mu$ s
<b>Low Voltage Range</b>						
Voltage Range	$\pm 9.999$	$\pm 9.999$ V	$\pm 9.999$ V	$\pm 16.383$ V	$\pm 32.7675$ V	$\pm 16.383$
Resolution	1 mV	1 mV	1 mV	1 mV	0.5 mV	1 mV
W/Option -07	100 $\mu$ V	100 $\mu$ V	100 $\mu$ V	—	—	—
90-Day Accuracy <sup>2</sup>	$\pm 100$ $\mu$ V	$\pm 100$ $\mu$ V	$\pm 100$ $\mu$ V	$\pm 100$ $\mu$ V	$\pm 160$ $\mu$ V	$\pm 100$ $\mu$ V
$\pm 0.01\%$ of output						
90-Day Stability <sup>3</sup>	$\pm 60$ $\mu$ V	$\pm 70$ $\mu$ V	$\pm 70$ $\mu$ V	$\pm 70$ $\mu$ V	$\pm 105$ $\mu$ V	$\pm 60$ $\mu$ V
$\pm 0.003\%$ of output						
Ripple and Noise <sup>4</sup>	300 $\mu$ V rms	500 $\mu$ V rms	500 $\mu$ V rms	500 $\mu$ V rms	500 $\mu$ V rms	300 $\mu$ V rms
Programming Noise	130 mV p-p	130 mV p-p	130 mV p-p	130 mV p-p	130 mV p-p	130 mV p-p
<b>High Voltage Range</b>						
Voltage Range	—	$\pm 65.00$ V	$\pm 99.99$ V	$\pm 65.53$ V	$\pm 110$ V	—
Resolution	—	10 mV	10 mV	4 mV	2 mV	—
W/Option -07	—	1 mV	1 mV	—	—	—
90-Day Accuracy <sup>2</sup>	—	$\pm 700$ $\mu$ V	$\pm 700$ $\mu$ V	$\pm 300$ $\mu$ V	$\pm 530$ $\mu$ V	—
$\pm 0.01\%$ of output						
90-Day Stability <sup>3</sup>	—	$\pm 490$ $\mu$ V	$\pm 490$ $\mu$ V	$\pm 210$ $\mu$ V	$\pm 370$ $\mu$ V	—
$\pm 0.003\%$ of output						
Ripple and Noise <sup>4</sup>	—	1 mV rms	1.2 mV rms	1 mV rms	1.2 mV rms	—
Programming Noise	—	260 mV p-p	260 mV p-p	260 mV p-p	260 mV p-p	—

\*Also 1% steps to 11% with IEEE-488 interface. Limit at 120% of range without Option -06

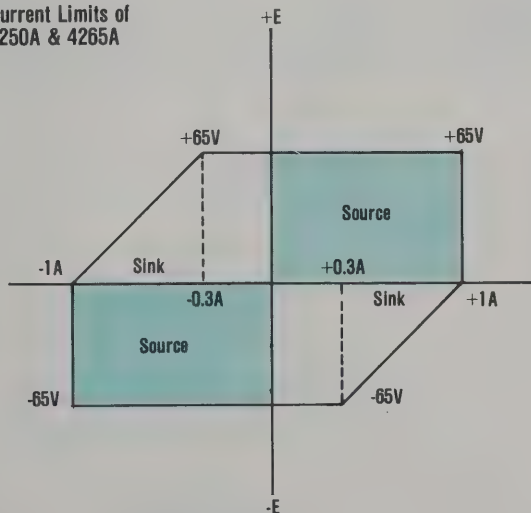
1. Percent of output, no load to full load,  $\pm 10\%$  line change

2. 15°C to 35°C

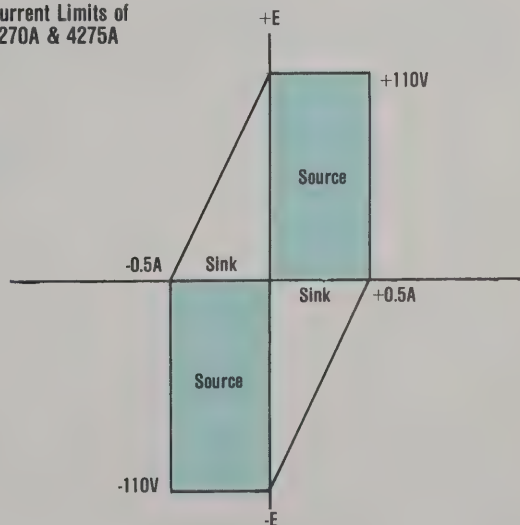
3. At constant line, load, and temperature

4. 10 Hz to 10 MHz bandwidth

**Current Limits of  
4250A & 4265A**



**Current Limits of  
4270A & 4275A**





# PROGRAMMABLE POWER SUPPLIES

## 4200 Series

### General Specifications

**Shock:** 20G, 11 millisecond half-sinewave

**Vibration:** 4.5G, 10 Hz to 55 Hz

**Altitude:** ≤10,000 feet, operating; ≤50,000 non-operating

**Temperature:** 0°C to 50°C operating; -40°C to +75°C non-operating

**Power:** 115V or 230V ac ±10%, 48 Hz to 62 Hz. 4210A and 4216A 15W;

4250A and 4265A 100W; 4270A and 4275A 200 W

#### Size

**4210A and 4216A:** One half 19-inch rack width, 13.3 cm H x 21.6 cm W x 40.9 cm D (5.25 in x 8.5 in x 16.13 in)

**Others:** Full 19-inch rack width, 13.3 cm H x 43.2 cm W x 49.7 cm D (5.25 in x 17 in x 19.56 in)

#### Weight

**4210A and 4216A:** 5.5 kg (12 lb)

**Others:** 15.9 kg (35 lb)

**Included:** Instruction manual, service manual, power cord, mating digital input cable connector, screw terminal outputs. Order Y8021, Y8022, or Y8023 cable separately for Option -05.

### Models

January 1985 prices

4210A* Programmable Power Source, 100 mA	\$2395
4216A* Programmable Power Source, 100 mA	2395
4250A* Programmable Power Source, 1A	3445
4265A* Programmable Power Source, 1A	3445
4270A* Programmable Power Source, 500 mA	3745
4275A* Programmable Power Source, 500 mA	3745

\*Interface Option -01, -05, or -09 is also required

### Options\*

#### 4210A and 4216A

4200A-01 Isolated Control Logic	450
4200A-03 External Reference	345
4200A-05 Interface for IEEE-488 bus	550
4210A-07 100 $\mu$ V Resolution (4210A only)	495
4210A-09 Multi-strobe Logic (4210A)	795
4216A-09 Multi-strobe Logic (4216A)	795

#### 4250A and 4265A

4200A-01 Isolated Control Logic	450
4200A-03 External Reference	345
4200A-05 Interface for IEEE-488 bus	550
4250A-06 Programmable Current Limit	345
4250A-07 100 $\mu$ V Resolution (4250A only)	495
4250A-09 Multi-strobe Logic (4250A)	795
4265A-09 Multi-strobe Logic (4265A)	795

#### 4270A and 4275A

4200A-01 Isolated Control Logic	450
4200A-03 External Reference	345
4200A-05 Interface for IEEE-488 bus	550
4270A-06 Programmable Current Limit	345
4270A-07 100 $\mu$ V Resolution (4270A only)	495
4270A-09 Multi-strobe Logic (4270A)	795
4275A-09 Multi-strobe Logic (4275A)	795

\* All options are field-installable. To order, add a "K" to the option number, example 4200A-03K. Contact the Parts Department for field installation of the -07 and -09 options. Order Cable Y8021, Y8022, or Y8023 separately.

### Accessories (See page 230)

#### Rack Adapters for 4210A and 4216A

M05-200-603 5¼", Dual	110
M05-203-601 5¼", Offset	110
M05-203-602 5¼", Centered	110

#### Rack Adapter for 4250A, 4265A, 4270A, 4275A

M05-205-600 5¼"	85
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#### Rack Slides for M05-200-603 and M05-205-600

M00-260-610 18"	105
M00-280-610 24"	110

#### A4200 Manual Control Unit with Cable

4210A-4014 PCB Extender Board	75
4270A-4303 PCB Extender Cable	75
Y8021 1m Cable, for IEEE-488 bus	85
Y8022 2m Cable, for IEEE-488 bus	95
Y8023 4m Cable, for IEEE-488 bus	105

### After-Warranty Service (See page 227)

SC1-4210A, per 90-day interval	176
SC1-4216A, per 90-day interval	176
SC1-4250A, per 90-day interval	308
SC1-4265A, per 90-day interval	308
SC1-4270A, per 90-day interval	396
SC1-4275A, per 90-day interval	428

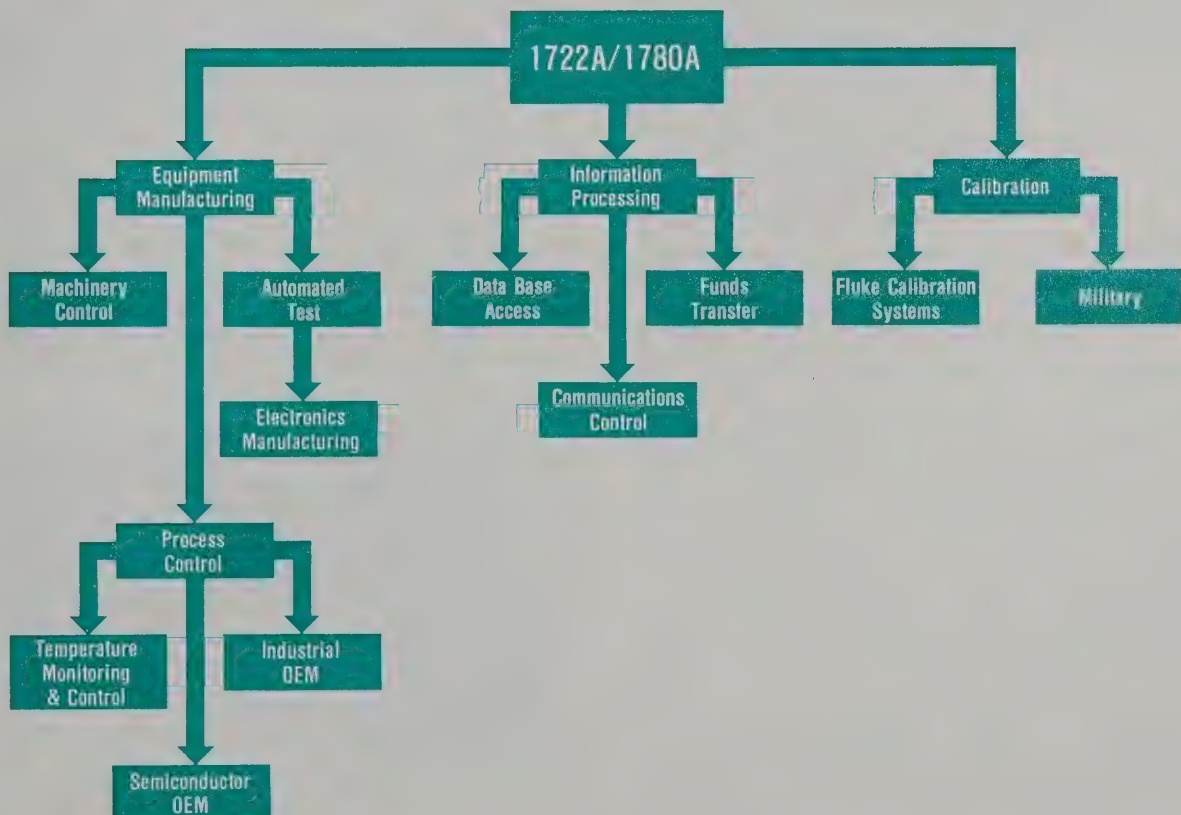
# INSTRUMENT CONTROLLERS

## Instrument Controllers and Touch Sensitive Displays

- Flexible interfacing to your equipment
- A choice of languages for your programmers
- High-speed 16-bit microprocessors
- Rack mountability for easy integration
- Patented touch-sensitive displays for user interfacing
- Attractive OEM contract terms
- Complete Fluke support and service

Over the past five years, Fluke has increased its business ten-fold in the area of computer equipment and peripheral. Hardware and software products are offered for those who are automating processes in the area of electronics manufacturing, testing, data acquisition, and overall machine and system control. Also offered are complete, flexible configurations, minimizing your implementation costs to match the complex and varied needs of the customer.

## Instrument Controller Applications





# INSTRUMENT CONTROLLER

## 1720A



1720A

### 1720A Instrument Controller

- Microcomputer architecture designed for instrument control
- Touch sensitive display
- Rack mountable with removable keyboard
- Soft-loaded operating system
- 64K RAM memory
- Includes two each IEEE-488 and RS-232 interfaces
- Battery backed-up E-Disk™ available, up to 256K bytes
- BASIC, FORTRAN, Assembly

The 1720A Instrument Controller is the predecessor to the new 1722A. It is an industrial microcomputer designed and built to control both IEEE-488 and RS-232-C compatible programmable instrumentation systems in the factory, field, or lab environments. Like the new 1722A Instrument Controller, the 1720A features a touch-sensitive operator interface, simple rack or tabletop mounting, and soft-loaded software.

While the 1722A is recommended for new applications, the 1720A will continue to be supported for many years for use in systems that are already designed. Furthermore, a number of options, peripherals, and accessories are available to increase the capability of presently-installed systems. Fluke is committed to preserving the investment you have made in both hardware and software for your Fluke system.\*

### Standard Features

- Touch sensitive display
- Detachable programmer's keyboard
- 60K bytes of read/write memory
- 200K-byte floppy disk
- Dual IEEE-488 ports
- Dual RS-232-C ports
- Soft loaded operating system with BASIC Interpreter

### Options & Peripherals

#### E-Disk™ Option (-001)

The "electronic disk" is dynamic RAM which emulates a fixed-head disk and is accessed just like the floppy disk but faster. Each is a module of 128K bytes. Two modules can be inserted in each 1720A for a total of 256K bytes of additional memory.

Data can be stored and transferred at a rate of 130K bytes per

second, eight times faster than the floppy disk. This speed allows programs which are too big for main memory to be chained together and loaded quickly with negligible delay. Sequential files and virtual data arrays can be built up much larger than in main memory, with little sacrifice in processing speed.

For data and program file protection from power interruptions, the 1720A has an internal battery that will back up the contents of one E-Disk module for about one hour, or two for about a half hour. The back-up period may be extended indefinitely by using an external battery connected through the remote interface connector on the rear panel.

#### Bubble Memory Options (-004 and -005)

The -004 and -005 options are bubble memory boards that provide either 256K bytes (-004) or 512K bytes (-005) of file storage. The transfer rate is 25K bytes per second.

Bubble memory is a solid-state medium which is immune to pollution and vibration, making it ideal for harsh environments where floppy disk operation is not practical. Bubble memory is non-volatile, so it does not require battery back-up to retain its file contents through a power loss. Since bubble memory has a much greater tolerance to temperature extremes than other media, the 1720A can operate from 0°C to 50°C when bubble memory is the primary file storage medium.

#### Winchester Disk Drive (1765A/AB)

The 1765A/AB is a 5¼-inch Winchester Disk Drive that provides 5M bytes of mass file storage when used with the 1720A. It interfaces to the 1720A via one of the IEEE-488 ports. Transfer rate is 22K bytes per second.

#### External Floppy Disk Drive (1760A and 1761A)

Additional file storage and easy disk copying is available with either a single or a dual 5¼-inch floppy disk drive (models 1760A and 1761A, respectively). These drives feature 400K bytes of storage for the 1760A and 800K bytes for the 1761A. They interface to the 1720A via one of the IEEE-488 ports. Transfer rate is 22K bytes per second. Up to two 1761As can be accommodated, for a total of 1.6M bytes of on-line floppy disk file space.

#### Parallel Interface Option (-002)

For controlling instruments and other peripherals, the Parallel Interface Option has two independent 16-bit data ports with four control lines each. Software drivers for the interface allow bidirectional transfer of bits, words, and multi-word blocks with complete handshake and strobe protocols. The option has strobe protocols, independent jumper-configurable active sense-levels for control, input data, and output data of each port. Up to two Parallel Interface Options can be installed in each 1720A.

### BASIC Software Development System

The 1720A is supplied with interpretive BASIC, an extension of ANSI Standard BASIC with special commands for the IEEE-488 bus. Its key features include:

- Full screen editing
- Immediate-mode execution of statements
- Trace of line numbers during program execution
- Trace of variable value changes
- Breakpoint setting
- Single-step program execution
- Line renumbering
- Deletion of blocks of lines
- Utilities for controlling touch-sense operation
- Calls to FORTRAN or Assembly routines

\* The Fluke 1720A & 1722A have been incorporated into a number of Fluke calibration systems. See pages 91 through 147 for more detailed information.

# INSTRUMENT CONTROLLER

1720A

## Compiled BASIC Option (-203)

The Compiled BASIC system is designed to enable users of the 1720A to take advantage of a compiled language while providing the capability to compile Fluke Enhanced Interpretive BASIC programs. The advantages of this system area:

- Program execution 3 to 5 times faster than Interpretive BASIC
- Supports subroutines written in FORTRAN, or Assembly Language
- Local variable names
- Use of program overlays for large programs
- Interrupts at intervals and at a given clock time
- Three dimensional arrays
- Alphanumeric labels for lines and/or statements
- Long variable names
- Continuation lines — up to 200 lines per line number
- General purpose text editor

## FORTAN Development System (-202)

Fluke FORTRAN (ANSI FORTRAN IV), is a compiled FORTRAN. It includes all utilities and linkers with special subroutines for IEEE-488 control and I/O systems. Its key features include:

- Sequential files and records
- Formatted and unformatted I/O
- Program overlays
- Double-precision and mixed-mode arithmetic
- Relational and logical operators
- Complete set of IEEE-488 subroutines
- Library manager program
- Utilities for controlling touch-sense operation

## Assembly Language Development System (-201)

The assembly language used on the 1720A has a dynamic linking ability which allows software programmers to write specialized routines to accomplish a specific task, then call and link the subroutines from BASIC and FORTRAN. A preprocessor is used to simplify code, with no loss in execution time or memory space efficiency. Key features include:

- Structured code
- Automatic updating of nesting-levels of comments
- Special preprocessor constructs for easy writing, maintenance, and editing
- Fast execution time

## Configured System Software (-700)

Standard 1720A System Software includes drivers for all devices that are part of the standard 1720A as well as the optional E-Disk. However, if your system includes a -004 or -005 Bubble Memory Option or a 1760A, 1761A, or 1765A/AB Disk Drive, you will need 1720A-700 Configured System Software. This keeps the amount of memory occupied by operating system software to a minimum.



1720A with Keyboard

## Specifications

**Temperature:** 10°C to 40°C, operating; -10°C to +60°C for 1720A and +10°C to +52°C for floppy disks, non-operating  
**Relative Humidity:** 8% to 80%, operating; 5% to 95% for 1720A and 8% to 90% for floppy disks, non-operating, non-condensing  
**Power:** 90V to 132V ac or 180V to 264V ac, 47 to 63 Hz; 103.5V to 126.5V ac, 400 Hz; 150W maximum  
**Size:** 14.7 cm H x 43.5 cm W x 61.4 cm L including feet and handles (5.8 in x 17.1 in x 24.1)  
**Weight:** Controller 16 kg (35 lb); Keyboard 1.4 kg (3 lb)  
**Included:** Y1720 Keyboard, Operator's manual, User manual, Service manual, Programming manual, Programmer reference guide, BASIC system disk, diagnostic disk, Programmer's worksheets (pad of 50),

## Model

January 1985 prices

1720A Instrument Controller ..... \$9400

## Options

1720A-001 128K Byte E-Disk ..... 2450  
 17XXA-002 Parallel Interface ..... 790  
 17XXA-004 256K Bubble Memory ..... 3250  
 17XXA-005 512K Bubble Memory ..... 5450  
 1720A-201 Assembly Software Package ..... 995  
 1720A-202 FORTRAN Software Package ..... 1495  
 1720A-203 Compiled BASIC Software Package ..... 995  
 1720A-700 Configured 1720A System Software ..... 95

## Peripherals

1760A 400K Byte External Disk Drive ..... 1950  
 1761A 800K Byte External Disk Drive ..... 2950  
 1765A/AB 5M Byte Winchester Disk ..... 4250  
 1780A InfoTouch® Display ..... 1995

## Accessories (Also see page 230)

Y1702 2m RS-232-C Null Modem Cable ..... 125  
 Y1703 4m RS-232-C Null Modem Cable ..... 150  
 Y1704 Circuit Board Extender ..... 200  
 Y1705 0.3m RS-232-C Null Modem Cable ..... 75  
 Y1706 Double-Sided Blank Disks (package of 10) ..... 100  
 Y1707 2m RS-232-C Interface Cable ..... 125  
 Y1708 10m RS-232-C Interface Cable ..... 150  
 Y1709 2m Printer Cable ..... 125  
 Y1711 Shipping Case ..... 300  
 Y1720 Programmer's Keyboard ..... 350  
 Y1790 Rack Mount Kit with 24" Slides ..... 175  
 Y8021 1m Interface Cable for IEEE-488 bus ..... 85  
 Y8022 2m Interface Cable for IEEE-488 bus ..... 95  
 Y8023 4m Interface Cable for IEEE-488 bus ..... 105

## After-Warranty Service (See page 227)

SC1-1720A, per 90-day interval ..... 540

## On-Site Service Agreement available

See page 227 for more information.



# INSTRUMENT CONTROLLER

## 1722A



1722A With Keyboard

### 1722A Instrument Controller

- Microcomputer architecture designed for system control
- Touch display operator interface
- BASIC, FORTRAN, and Assembly programming language options
- Rack mountable with removable keyboard
- 136K RAM memory expandable to over 2.6 megabytes
- High resolution graphics with graphics print capability
- RS-232-C, IEEE-488, RS-422, or 20 milliampere current loop and bit parallel interfaces
- High speed floating point processing implemented in firmware
- Soft-loaded operating system

The 1722A represents the evolution of a concept pioneered and introduced by Fluke in 1979 — the concept of using a touch-sensitive CRT display as the primary interface between an operator and a high-performance instrument controller. Few things could be more user-friendly. And it allowed the keyboard to be treated as a programming tool, usually unplugged and removed from an operating instrumentation system. Rack mounting was simple.

Fluke's first instrument controller was the 1720A. The 1722A has improved capabilities. But, because we are committed to maintaining the highest possible level of software compatibility consistent with evolutionary improvements, the 1722A runs programs that were developed for even the first 1720As delivered. As we continue to develop microcomputer products at Fluke, the software investments made by our customers remain a foremost design consideration.\*

### High Performance Microcomputer

The 1722A, is a microcomputer designed for control of automated instrument systems in the laboratory, the plant, or the factory and for information management systems.

The 1722A is an entirely new design internally. The high speed 16-bit microprocessor uses a 24 MHz clock to achieve an instruction cycle rate of 6 MHz. High-speed floating point arithmetic processing is implemented through extensions to the microprocessor instruction set. A separate display processor, with high speed vector generator and graphics memory workspace, functions as an independent graphics display terminal for the central processor.

When started up, the 1722A looks to its internal floppy disk (or to optional internal bubble memory) for operating software. Updating to newer software is a simple matter of inserting a disk and restarting. You are not tied to permanently-installed ROMs. Yet the 1722A is easily set up to automatically start running your application. After loading operating software, it looks for a start-up command file. The file is treated as keyboard inputs, instructing the controller to perform any task sequence. If software is stored in optional non-volatile bubble memory, you never need to bring a disk near it.

RAM memory in the 1722A can be partially allocated as a file-structured electronic disk, for high speed task overlays and large, fast-access virtual data arrays. Software development tools make the task of writing programs more efficient through such features as wildcard file identification, utility command files, and recall of previously typed commands.

The 1722A includes five slots for additional memory and interface options. The standard 136K RAM memory is internally expandable to

\* The 1720A and 1722A have been incorporated into a number of Fluke calibration systems. See pages 91 through 147. Also the 2452MCS Measurement and Control System combines the power of the 1722A and the 2400B. See page 199.

# INSTRUMENT CONTROLLER

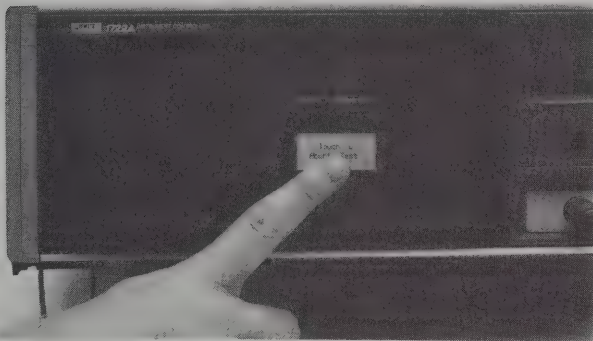
1722A

over 2.6 megabytes. The 400K-byte internal floppy disk drive capacity can be expanded through the 1760A or 1761A Disk Drives to 2 megabytes of on-line floppy disk file storage. The 1765A/AB Winchester Disk Drive System brings 10 megabytes of file capacity on-line. And bubble memory options can be installed for up to 1.3 megabytes of rugged, non-volatile file storage especially well suited for harsh environments.

## Touch-Sensitive Display System

With its touch-sensitive display, the 1722A is particularly well suited for applications where semi-skilled personnel need to operate complex systems performing sophisticated tasks. The friendly graphics display takes the place of the often-intimidating keyboard, yet offers access to the software that keeps your system running. An operator is prompted one step at a time for information or decisions through informational displays, and responds by simply touching the screen. The predictability of procedures allows true trend analysis to be performed, pinpointing common failure modes or process impediments. Systems based on this concept are easily updated for new tasks. The cost and downtime of installing new switch or key labels is eliminated.

Fluke's experience producing the touch-sensitive display overlay goes back to 1979. It has proven to be a rugged, reliable component.



Touch-sensitive interactive display

## Characters Plus Graphics

The graphics display capability of the 1722A is independent of its character display, and of the 1722A central processor. With its own display processor, high speed vector generation hardware, and 64K graphics display memory, the 1722A is a sophisticated tool in the hands of the creative system designer. The 64K display workspace is over three times the size of the 640 by 224 pixel display window: 2048 pixels wide by 256 pixels high. You can use it to display data in strip chart form, and move the display across the window by touch commands. You can also use it to prepare up to three independent data screens available for instant display. Once the graphics display is generated, a hard copy of the graphics plane can be printed under program control.

The 1722A character display is an independent function that can overlay graphics data displays for labels, or be used alone for text and for programming. Because the graphics and character displays can be independently enabled, screens can be prepared "off-line" and displayed when ready. Numerous ANSI-compatible character attributes are available to add emphasis to portions of displays. Attributes such as inverse or underline can be pre-defined for display fields, or made a part of characters as they are sent to the screen.

The 1722A includes an industry standard composite video output that will display whatever is on the 1722A screen on a video monitor. This can be useful for training presentations as well as for system requirements that include a remotely mounted display.

## Interfacing

The 1722A includes an IEEE-488 bus interface and an RS-232-C serial data port. The IEEE-488 interface can control up to 14 instruments at transfer rates of up to 30K bytes per second. Powerful IEEE-488 commands are supported as a part of each 1722A programming language. The 1722A can be set up to function as a system controller or as an addressable device in a multiple-controller system. In either configuration, the 1722A can pass control to another controller and take it back when offered. As system controller, the 1722A starts up as controller-in-charge and can use IFC (Interface Clear) to reset all bus devices.

Three of the five expansion slots are available for additional interfaces:

Option 17XXA-008 adds an IEEE-488 interface and an additional RS-232-C serial data port. The 1722A can accommodate up to two IEEE-488 ports.

Option 17XXA-009 is a reconfigurable, dual serial-data port with its own buffer memory. It is supplied configured for RS-232-C with full modem compatibility. Each port can be easily reconfigured for a 20 milliamp current loop, or for RS-422 balanced lines. Up to three -009s may be installed for a total system of seven serial ports.

Option 17XXA-002 (Parallel Interface) gives you two independent 16-bit parallel I/O ports that can function as independent lines, 8-bit bytes, or 16 or 32-bit words. Line protocol is available (but not required), and the sense of the data can be reconfigured to either High true or Low true. A maximum of three modules may be installed for a total of six 16-bit ports.

## Options & Peripherals

### RAM Expansion Modules (-006, -007)

The internal program and data space can be expanded to over 2.6M bytes with RAM expansion modules. These modules can be added in either 256K or 512K byte increments. Your software can easily assign part of the RAM memory to perform an "electronic disk" function. Once programs are downloaded from floppy-disk drive, the 1722A will run entirely out of the electronic disk.

### Bubble Memory Options (-004, -005)

The -004 and -005 options are bubble memory boards that provide either 256K (-004) or 512K (-005) bytes of file storage. The transfer rate is 25K bytes per second.

Bubble memory is solid-state medium which is immune to pollution and vibration, making it ideal for harsh environments where floppy disk operation is not practical. Bubble memory is nonvolatile, so it does not require battery back-up to retain its file contents through a power loss. Since bubble memory has a much greater tolerance to temperature extremes than other media, the 1722A can operate from 0°C to 40°C when bubble memory is the primary file storage medium.

### External Floppy Disk Drive Systems (1760A and 1761A)

The Fluke 1760A Disk Drive and 1761A Dual Disk Drive each provide high capacity floppy disk file storage. The 1760A and 1761A use double-density dual-head disk drives. The full on-line capacity is 400K bytes for the 1760A, and 800K bytes for the 1761A, including a file directory for each floppy disk. They interface to the 1722A via the IEEE-488 port. Both systems are rack mountable and easy to install and use. Transfer rate is 22K bytes per second. Up to two 1761As can be accommodated, for a total of 2M bytes of on-line floppy disk file space.

### Winchester Disk Drive (1765A/AB)

The 1765A/AB is a 5¼-inch Winchester Disk Drive that provides 10M bytes of mass file storage when used with the 1722A. It interfaces to the 1722A via the IEEE-488 port. Transfer rate is 22K bytes per second.

## System Software

The 1722A's operating system combines the best features of both benchtop computers and minicomputers. Like a benchtop unit, the user can power-up the 1722A and immediately begin programming in



# INSTRUMENT CONTROLLER

## 1722A

BASIC. Advanced operating system features like the alias file, command files, system shell command, an advanced Editor, and the powerful File Utility Program, simplify the task of developing your application programs. For example, an entire disk can be copied with one short statement. Command files can be set up to automate repetitive tasks, and feature multiple parameter passing, as well as an interactive mode. A system command file can define a start-up sequence for turn-key operation. All these features add up to increased productivity for programmers.

### BASIC Software Development System

The Fluke Enhanced BASIC Interpreter, standard with the 1722A, is an extension of ANSI standard BASIC and includes statement common to IEEE-488 for comprehensive instrument control. The interpreter can call modules written in Assembly language or FORTRAN for flexibility and high-speed processing. Virtual arrays simplify the use of mass storage devices such as bubble memories and external disk drives. An easy-to-use four-key screen editor and comprehensive debugging tools cut program development time. Other features include:

- Immediate mode execution of statements
- Two dimensional arrays
- Trace of line numbers or variables during program execution
- Breakpoint setting
- Single-step program execution
- Automatic line renumbering
- File manipulation commands
- Complete interrupt processing including touch-sensitive screen, serial ports, IEEE-488 ports, timers, and errors
- Ability to link FORTRAN & Assembly subroutines

### Compiled BASIC Option (-203)

The Compiled BASIC Option provides greater flexibility and speed while maintaining the ability to compile Fluke Interpretive BASIC. Programs can be run three to five times faster with Compiled BASIC than with Fluke Interpreted BASIC, while using less memory. Compiled BASIC includes the capability of linking subroutines of FORTRAN or Assembly Language.

Compiled BASIC permits large multiple-line statements, and long descriptive variable names. It also permits labels to be used in place of line numbers for branch targets while leaving the use of line numbers optional. Compiled BASIC subroutines exchange parameters, and use local variables and common variables for true modularity. This freedom of format allows BASIC programs to be written in a readable, structured form. Multiple-line statements can be especially useful, for example, when a program requires many lines following an IF statement. Key features include:

- Program execution 3 to 5 times faster
- Local variable names
- Use of program overlays for large programs
- Interrupts of intervals and at a given clocktime
- Three dimensional arrays
- Alphanumeric labels for lines and/or statements
- Long variable names
- Continuation lines — up to 200 lines per line number
- General purpose text editor
- Ability to link FORTRAN and Assembly subroutines

### Extended BASIC Option (-205)

The Extended BASIC Option provides a compiler that allows the 1722A programmer to easily develop large BASIC programs without having to use a complex overlay structure that can be required when using Fluke Compiled BASIC. (Program space can be over two megabytes.) The statements and syntax are the same as those found in our Compiled BASIC. Key features include all those mentioned for Compiled BASIC except execution speed is only twice as fast as Fluke Interpreted BASIC, while eliminating complex program overlays.

### FORTAN Development System (-202)

This option, an enhanced version of FORTRAN IV (ANSI x3.9-1966), gives the 1722A tremendous flexibility and speed. With it, you can use FORTRAN libraries covering thousands of applications. The system

includes a FORTRAN Compiler, Linking Loader, Linkage Editor (for creating programs larger than available memory) and Library manager. Comprehensive error messages are included to make programming more efficient. Features of Fluke FORTRAN include:

- Sequential files and records
- Formatted and unformatted I/O
- Program overlays
- Double-precision and mixed mode arithmetic
- Relational and logical operators
- Complete set of IEEE-488 subroutines
- Library manager program
- Screen menus and touch-sensitive operation subroutines
- FORTRAN subroutines callable from BASIC

### Assembly Language Development System (-201)

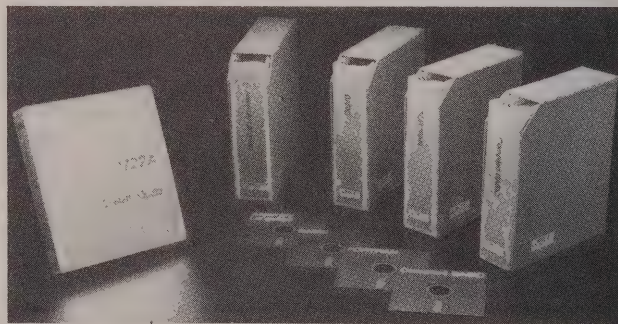
This option allows specialized routines to be assembled into machine language and linked from BASIC or FORTRAN as subroutines. The package includes a structured preprocessor which allows assembly code to be written using high-level language constructs for looping and decision making. Two operational modes are allowed: non-privileged, which protects the user from inadvertently changing the resident operating system, and privileged, which allows maximum flexibility. Using Macrostore™, single- and double-precision floating point arithmetic instructions become part of the assembly language, simplifying code in applications where floating-point manipulations are required and even further speeding execution time. Features of Option -201 are:

- Dynamic linking of assembly routines via BASIC
- Structured code
- Automatic updating of nesting-levels of comments
- Special high-level preprocessor constructs
- Hex Debugging Tool with disassembly capability
- Privileged and non-privileged modes
- Macrostore floating point operations

### Module-Level Diagnostics

The 1722A is a modular design with diagnostic software that allows semi-skilled operators to identify failures to the module level. Spare-module kits are available for the most time-critical applications. Fluke also maintains an inventory of 1722A modules that may be shipped within hours in most cases, and which can be exchanged for a defective module for a nominal charge. Contact your Fluke Technical Service Center for more information.

*Macrostore™ is a trademark of Texas Instruments, Incorporated*



### Manuals That Make the Task Easy

Experience will tell you that the major investment in an automated instrument system is not usually in the hardware, but in system integration and the development of application software to run it. The quality of documentation is a key consideration. You will find that 1722A manuals are among the most readable, consistent, and sensible software documentation available anywhere. Ask your Fluke Sales Engineer or Representative to let you evaluate the 1722A through its manuals. You will be pleasantly surprised.

## INSTRUMENT CONTROLLER

1722A

## OEM Sales — 1722A in Your Products

The 1722A is used as a component part of many products manufactured by companies other than Fluke. Custom packaging and matching paint colors are routinely negotiated. Fluke offers the discounts, policies, and worldwide support to make it work, too. If you are designing a product that would be more competitive with a touch-sensitive graphics display and a high performance microcomputer system, call your Fluke Sales Engineer or Representative for more information.

## Specifications

**Temperature:** 10°C to 40°C with floppy disk, operating; 0°C to 40°C without floppy disk, operating. 10°C to 52°C with floppy disk, non-operating; -20°C to 60°C without floppy disk, non-operating

**Relative Humidity:** 20% to 80%, non-condensing, operating; 8% to 90% non-condensing, with floppy disk, non-operating or 5% to 95%, non-condensing, without floppy disk, non-operating

**EMI and RFI Emissions:** Tested to FCC Part 15, Subpart J, Class B; VDE 0871, Class B; CISPR 11-1975

**Power:** 90V to 132V ac or 180V to 264V ac, 47 Hz to 440 Hz. 175W maximum

**Size:** 13 cm H x 43 cm W x 55 cm L (5.25 in x 17 in x 21.5 in) plus feet

**Weight:** 14.5 kg (34 lb). Keyboard 1.4 kg (3 lb)

**Included:** Y1700 Keyboard, power cord, BASIC system disk, diagnostic disk, "Getting Started" manual and disk, System Guide manual, Operator's manual, BASIC Programming Manual, and a pad of 50 display worksheets

## Model

January 1985 prices

1722A Instrument Controller .....	\$7450
1722A-1 Instrument Controller w/o Keyboard .....	7200

## Options\*

17XXA-002 Parallel Interface .....	790
17XXA-004 256K Bubble Memory .....	3250
17XXA-005 512K Bubble Memory .....	5450
17XXA-006 256K-Byte RAM Expansion .....	1550
17XXA-007 512K-Byte RAM Expansion .....	2250
17XXA-008 IEEE-488/RS-232 Interface .....	590
17XXA-009 Dual Serial Interface .....	850
17XXA-201 Assembly Language Software Development System .....	1495
17XXA-202 FORTRAN Software Development System .....	1495
17XXA-203 Compiled BASIC Software Development System .....	490
17XXA-205 Extended BASIC Software Development System .....	490

\*All options are customer installable

## Peripherals

1760A 400K Byte Disk Drive .....	1950
1761A 800K Byte Dual Disk Drive .....	2950
1765A/AB 10M Byte Winchester Disk .....	4250
1780A InfoTouch® Display .....	1995

## Accessories (Also see page 230)

Y1700 Programmer's Keyboard .....	395
Y1702 2m RS-232-C Null Modem Cable .....	125
Y1703 4m RS-232-C Null Modem Cable .....	150
Y1704 Circuit Board Extender .....	200
Y1705 0.3m RS-232-C Null Modem Cable .....	75
Y1706 Double-Sided Blank Disks (package of 10) .....	100
Y1707 2m RS-232-C Interface Cable .....	125
Y1708 10m RS-232-C Interface Cable .....	150
Y1709 2m Printer Cable .....	125
Y1711 Shipping Case .....	300
Y1790 Rack Mount Kit with 24" Slides .....	175
Y1795 Carrying Handle for portability .....	48
Y8021 1m Interface Cable for IEEE-488 bus .....	85
Y8022 2m Interface Cable for IEEE-488 bus .....	95
Y8023 4m Interface Cable for IEEE-488 bus .....	105

## After-Warranty Service (See page 227)

SC1-1722A, per 90-day interval .....	480
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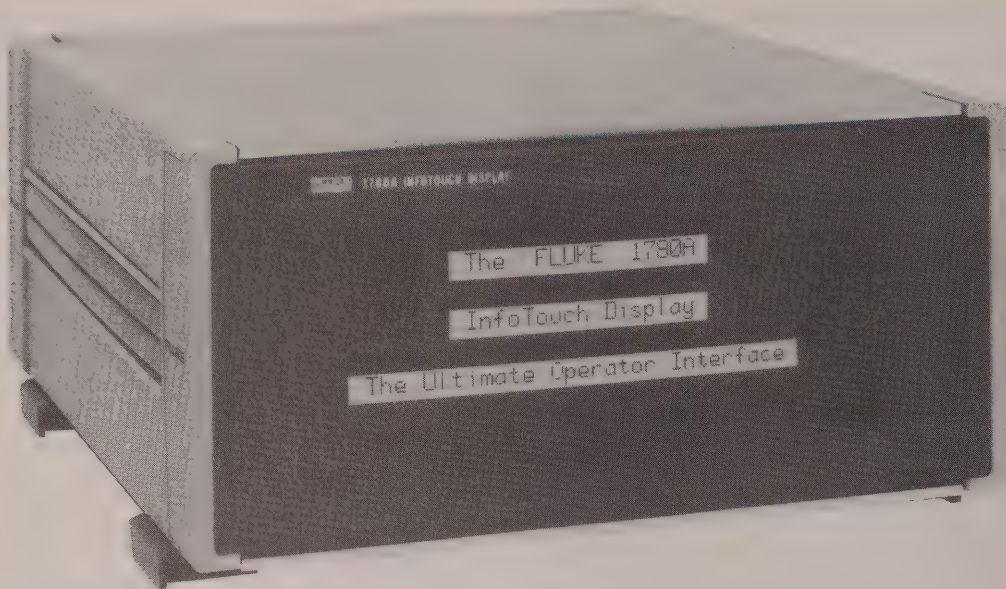
## On-Site Service Agreement available

See page 227 for more information.



# INFOTOUCH® DISPLAY

## 1780A



1780A

### 1780A InfoTouch® Display

- Flexible operator interface to computer-based systems
- Operates with any computer via RS-232-C interface
- 60 fingertip-sized touch sensitive areas
- Crisp, alphanumeric and character graphic display
- Compact, rugged packaging

The 1780A provides a simple yet sophisticated means of interfacing an operator to a complex control process.

Whether the operator is highly skilled in a particular manufacturing or test process, or is a first-time or occasional user of an on-line information system, the 1780A is the ideal link between the user and the computer at the heart of your system. The 1780A's display screen is used to present choices to the operator, and the transparent, touch-sensitive switch matrix overlaying the display receives the operator's response to those choices. Complicated processes can be performed in a series of steps, each involving a small number of choices.

The InfoTouch® Display eliminates the complexity of remembering and correctly entering system commands at a conventional keyboard. Information presented to the operator at any particular time is under program control, allowing the system to guide the operator through the correct sequence of operations. And since the operator can only act upon the choices presented to him on the display, the possibilities of error are greatly reduced. Information can be presented to the operator in numbers, letters, graphic messages, or custom symbols or alphabets. The touch-sensitive overlay covers most of the screen, and provides 60 fingertip sized touch areas.

In the simplest implementation, the InfoTouch® Display's integration of a display and touch sensitive overlay can be used to provide a more natural alternative to conventional function keys. Use of graphics characters and the flexibility afforded by the InfoTouch® Display allows replacement of analog or digital readouts, toggle switches, rotary controls, pushbuttons, and annunciators. Applications of the InfoTouch® Display to a wide variety of information and equipment control processes are limited only by your imagination.

Customizing the InfoTouch® Display panel is a simple programming task of writing and storing sequences of ASCII characters and display-control codes. Since the ASCII sequences are not dependent upon software language, the InfoTouch® Display can be used with virtually any host computer. And since the displays are stored in your computer's software or firmware, changes can be easily made as you update the capabilities of your system.

The standard InfoTouch® Display allows display of the full ASCII character set plus eleven standard graphics characters for simple line drawings or outlining touch-sense areas. Expanded graphics capabilities are optionally available via the 1780A-201 Expanded Graphics Character Set. This option provides 128 more graphics characters to let you generate complex process diagrams or other graphic displays. Or, if you like, you can customize the character sets for your particular system needs.

### OEM Configurations and Uses

The 1780A features a compact, rugged display ideally suited for incorporation into your system. It is equally at home sitting on a desk or bench, mounted into a standard 19" rack, or installed into a custom enclosure with other system components. Special configurations and quantity discounts are available to Original Equipment Manufacturers. Contact your Fluke Sales Engineer or Representative for complete information.

### System Compatibility

The 1780A InfoTouch® Display connects directly to any host computer with a standard RS-232-C interface. If your system can communicate with a conventional terminal, it can work with the 1780A. RS-422 communication capability is available in special configurations. Contact your Fluke Sales Engineer or Representative for complete information.

Fluke's 1720A and 1722A Instrument Controllers are suitable hosts for the 1780A, particularly in test and calibration systems employing IEEE-488 instrumentation. The character set and display control sequences are similar between the 1780A and 172XA controllers, allowing the 1780A to be a remote operator interface to these controllers.

# INFOTOUCH® DISPLAY

1780A

## Display Features

- 60 distinct touch-sensitive blocks on the display screen
- Large display capacity — 16 full-width 80 character lines
- ANSI standard display control codes
- Double-size character display mode
- Full cursor position and screen erase controls
- Underlining, blinking, reverse image, and highlighting
- All display characters user-definable in EPROM
- Eleven standard graphic characters
- Optional alternate character set adds 128 characters for expanded graphics or international applications
- High resolution green display for operator eye comfort



Relevant choices shown graphically



Call up a menu when needed

## International Design Standards

The 1780A InfoTouch® Display is designed for the international market. It automatically senses and adjusts its display scan for 50 Hz or 60 Hz power supply. Interconnection is through the widely accepted RS-232-C standard, using standard baud rates, ASCII codes, and ANSI-defined display control sequences.

Alternate, custom character sets can be easily designed to facilitate virtually any international application.

## Optional Keyboard Interface

The Keyboard Interface Option (-001) gives the 1780A another input and output mode in addition to the touch sensitive screen. It may be used with a customized keypad, test fixture, or with the Y1720 Programmer Keyboard for operation as a standard terminal. There are also five TTL output lines on the interface which can be controlled through remote commands from the host.

## Accessory Descriptions

Y1791 is a rack mount adapter with a blank filler panel. It allows the 1780A to be mounted to either the right or left side of standard 19-inch rack enclosures. Rack slides or a rack shelf are required for complete mounting of the 1780A in a rack.

Y1792 is a rack mount adapter with a keyboard extension cable. It is similar to Y1791 but includes an extension cable mounted to the filler panel which will extend the function of the 1780A-001 Keyboard Interface to the front panel. Rack slides or a rack shelf are required for complete mounting of the 1780A in a rack.

Y1720 Full ASCII keyboard.

## Specifications

Signal Emissions: FCC Part 15, Subpart J, Class A

Temperature: 0°C to 50°C, operating; -40°C to +65°C, non-operating

Relative Humidity: To 95% from 0°C to 25°C, 75% to 40°C, and 45% to 50°C, non-condensing

Power: 90V to 132V ac, or 198V to 264V ac, 47 to 63 Hz, 55W maximum

Size: 13.3 cm H x 28.8 cm W x 34.4 cm D (5.23 in x 11.35 in x 13.55 in).

Standard 5¼-inch rack height

Weight: 9.7 kg (22 lb)

## Model

January 1985 prices

1780A InfoTouch® Display ..... \$1995

## Options

1780A-001\* Keyboard Interface ..... 150

1780A-002\* Keyboard Interface with Y1720 Keyboard ..... 400

1780A-201 Expanded Graphics Character Set ..... 250

\*Customer installable

## Accessories (Also see page 230)

Y1702 2m RS-232-C Null Modem Cable ..... 125

Y1703 4m RS-232-C Null Modem Cable ..... 150

Y1705 0.3m RS-232-C Null Modem Cable ..... 75

Y1707 2m RS-232-C Cable ..... 125

Y1708 10m RS-232-C Cable ..... 150

Y1720 Keyboard ..... 350

Y1791 Rack Adapter\* ..... 95

Y1792\* Rack Adapter and Keyboard Cable ..... 195

Y1793 Carry Handle ..... 40

M00-260-610 18" Rack Slide Kit ..... 105

M00-280-610 24" Rack Slide Kit ..... 110

\*Separately order rack slides M00-260-610 or M00-280-610

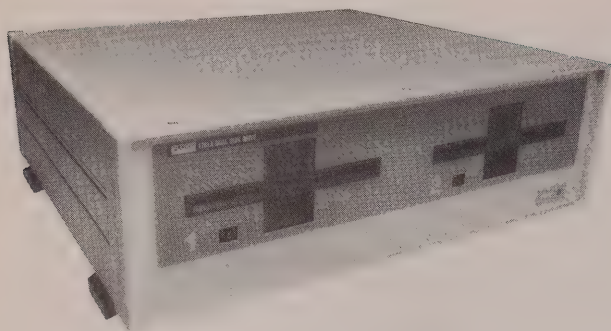
## After-Warranty Service (See page 227)

SC1-1780A, per 90-day interval ..... 112



# DISK DRIVE SYSTEMS

## 1760A/1761A Disk Drives



1761A Dual Disk Drive

### 1760A/1761A Disk Drive Systems

- Compatible with IEEE-488 bus controllers
- Software supported for Fluke 1720A and 1722A Instrument Controllers
- 400K bytes of on-line capacity (1760A)
- 800K bytes of on-line capacity (1761A)
- Low EMI and RFI emissions, designed for lab environments
- Rack mountable
- Automatic self-test
- Double-density, double-sided format
- 1720A single sided format also supported

The Fluke 1760A Disk Drive and 1761A Dual Disk Drive each provide high capacity floppy disk file storage for IEEE-488 bus systems. Rack mountable and supported with software for 1700-Series Instrument Controllers, you will find them easy to install and use. Installation is a matter of mounting and connecting the IEEE-488 bus cable. When used with a Fluke 1720A or 1722A Instrument Controller you will not need to be concerned with events and protocol on the IEEE-488 bus: available software for the Controllers allows either disk drive to be treated by application programs as if it were simply an additional drive installed in the controller.

Support software available for the 1722A Instrument Controller is provided with the controller. For use with the 1720A Instrument Controller, the Configured System Software Option (1720A-700) must be separately ordered. When ordering Option -700 for the 1720A, be sure to include a complete list of options and peripheral devices used. The Configured System Software works even if the supported devices are not yet installed.

### Specifications

**Access Time:** 505 ms, average  
**Transfer Rate:** 50K bytes per second, burst; 12K bytes per second, average, with typical sector interleave  
**On-line Capacity:** 400K bytes with 1760A, 800K bytes with 1761A  
**Track Density:** 48 tracks per inch  
**Speed:** 300 revolutions per minute  
**Recording Format:** 512 bytes per sector, 10 sectors per track, and 40 tracks per side (80 total). Double-density encoding  
**Disk:** Fluke-qualified industry-standard 5.25 inch, certified double-density, 40 tracks, both sides  
**Disk Life:** More than  $3 \times 10^6$  revolutions with head contact, per track  
**Error Rates:** 1 bit per  $10^9$ , recoverable; 1 bit per  $10^{12}$ , non-recoverable

### General Specifications

**Signal Emissions:** FCC Part 15, Subpart J, Class A; VDE 0871, Class B; CISPR 11-1975  
**Temperature:** 10°C to 40°C, operating; -10°C to 60°C, non-operating  
**Relative Humidity:** 20% to 90% from 10°C to 30°C, 20% to 80% from 30°C to 40°C, operating; 5% to 95%, non-operating  
**Power:** 90V to 110V ac, 108V to 132V ac, 198V to 242V ac, or 216V to 264V ac, selectable, 47 to 63 Hz. 55W for 1760A, operating; 70W for 1761A, operating  
**Size:** 13.3 cm H x 43.2 cm W x 39.6 cm D (5.25 in x 17.0 in x 15.6 in), both models  
**Weight:** 1760A is 7.7 kg (17 lb), 1761A is 9.1 kg (20 lb)

### Models

January 1985 prices

1760A Disk Drive System .....	\$1950
1761A Dual Disk Drive System .....	2950

### Option

1720A-700 Configured 1720A System Software .....	95
Y8021 1m IEEE-488 Cable .....	85
Y8022 2m IEEE-488 Cable .....	95
Y8023 4m IEEE-488 Cable .....	105

### After-Warranty Service (See page 227)

SC1-1760A, per 90-day interval .....	132
SC1-1761A, per 90-day interval .....	204

# DIGITAL THERMOMETERS & SYSTEMS

## Introduction

Temperature is one of the most commonly measured parameters in today's laboratory and industrial environments. To meet our user's needs for ever-increasing precision in temperature measurements, Fluke has applied its expertise in low level voltage measurement to develop a family of digital thermometers that are demonstrated leaders in quality and accuracy.

The Fluke family of digital thermometers ranges from low cost thermocouple adaptors for handheld multimeters to complete temperature logging systems. You will find that all of the Fluke temperature products are designed to be the highest quality and most accurate thermometers for the price. Industrial applications can now achieve lab accuracy.

## Selection Guide

Features	Panel Mount		Portable or Rackmountable							
	2160A	2170A	2165A	2166A	2168A	2175A	2176A	2190A	2180A	2189A
Pt, Ni, Cu Type RTDs	—	—	—	—	—	—	—	—	All	Pt
NBS Type B,E,J,K,R,S,T,C T/Cs*	All	E,J,K,T	All	All	All	E,J,K,T	E,J,K,T	All	—	—
DIN Type J,T T/Cs	No	No	No	No	No	No	No	Both	—	—
Measurement Resolution C or F	1°	0.1°	1°	1°	1°	0.1°	0.1°	0.1°	0.01°	0.01°
Number of Digits	4	4	4	4	4	4	4	5	5	5
Single Alarm Limit	2162A	2162A	—	—	—	—	—	-006	-006	-006
Multiple Alarm Limit	—	—	—	—	—	—	—	Y2002	Y2002	Y2002
Selectable Input Points	1	1	1	10	—	—	10	1	1	1
Multipoint Selector, Manual	2161A	2161A	**	—	**	**	**	Y2001	Y2000	Y2000
Points Per Selector	10	10	**	—	**	**	**	10	10	10
Maximum Points	30	30	**	—	**	**	**	100	100	100
Rechargeable Batteries	—	—	-01	Y2004	Y2004	-01	Y2004	Y2009	Y2009	Y2009
External 12V DC Operation	—	—	—	Yes	Yes	—	Yes	Yes	Yes	Yes
Analog Output Option	-04	-04	-04	-04	-04	-04	-04	-002	-002	-002
Digital Output Option	-02	-02	-02	-02	-02	-02	-02	-002	-002	-002

\*Type "C" is not an ANSI/ISA approved designation. It is used to designate Tungsten-5% Rhenium vs. Tungsten-26% Rhenium.

\*\*Works with 2161A Multipoint Selector except case style is different.

<sup>†</sup>Also see 2189A and 8520A/PRT Precision Thermometry Systems

## Thermometry Product Summary

**2160 and 2170 Series:** Low-cost, high-accuracy digital thermocouple thermometers in either bench/portable or panel mount styles for applications requiring 1 degree or 0.1 degree resolution.

**8520A/PRT:** Best accuracy from -200°C to +350°C. A Rosemount 162N Platinum Resistance Thermometer (PRT) and a Fluke 8520A 5½-Digit Precision Multimeter having a built-in, customized linearization curve to match the specific PRT.

**2180A, 2189A, and 2190A:** Fluke's most accurate and versatile general purpose digital thermometers for RTDs or thermocouples. You may stack and latch each thermometer to a wide range of accessories, including manual multipoints, multiple alarms, a battery pack, and a thermocouple calibrator.

**2300A Scanner:** Designed to be used with a 2180A or 2190A Digital Thermometer. The 2300A will automatically scan up to 100 points of temperature, using either a 2180A and RTDs or a 2190A and thermocouples. The unit can optionally run under computer control.

**Temperature Logging Systems:** Choose from four models — two for RTDs and two for thermocouples. These factory-tested systems include a thermometer, scanner, and printer for precision temperature logging that is also portable.

**2020A and 2030A Printers:** Allow you to log data from a thermometer or a scanner and thermometer. The 2030A permits mX+b math scaling and trend plotting.



## Digital Thermocouple Thermometers

Thermocouples are the most widely used temperature sensors. This is due to their simplicity, ruggedness, low cost and wide temperature range. A practical thermocouple consists of two wires made of dissimilar metals which have been joined together at one end (called the measurement junction) and thermally if not physically joined together at the other end (called the reference junction). The low dc voltage that is generated whenever the two junctions are at different temperatures is proportional to both the temperature difference and the absolute temperature of the two junctions.

A practical thermocouple circuit has the measurement junction placed at the point to be measured and the second at a known (reference) temperature. The thermoelectric voltage may be measured by connecting the copper leads of a sensitive voltmeter between the thermocouple wires at the reference junction. The temperature of the measurement junction can be determined by using tables published by the National Bureau of Standards that correspond to the type of thermocouple metals used.

## Ice Point Compensation

NBS Thermoelectric Tables are based on a reference junction temperature of 0°C, the Ice Point. This does not mean that the reference junction temperature must be maintained at 0°C; we only need to *know* its temperature to compensate for the difference from 0°C. Because the reference junction is in the measurement instrument and usually operating somewhere near 25°C, its temperature may be measured precisely using a semiconductor sensor. Ice Point compensation data is continuously available and continually applied.

## Thermocouple Types

**Type J, Iron-Constantan.** Range is -210°C to +760°C. Alloy becomes brittle below 0°C. For reducing atmospheres and suitable in vacuum and oxidizing atmospheres. Not for sulphurous atmospheres above 500°C. Color code: White plus, red minus.

**Type K, Chromel-Alumel.** Range is -270°C to +1370°C. For use in clean oxidizing or inert gas atmospheres. Not for vacuum at high temperatures. Peculiar problem of corrosion in low-oxygen atmospheres. Color code: Yellow plus, red minus.

**Type T, Copper-Constantan.** Range is -270°C to +400°C. More accurate than Type K in its more limited temperature range. For use in oxidizing reducing, inert gas, or vacuum atmospheres. Not suitable for use under nuclear radiation. Color code: Blue plus, red minus.

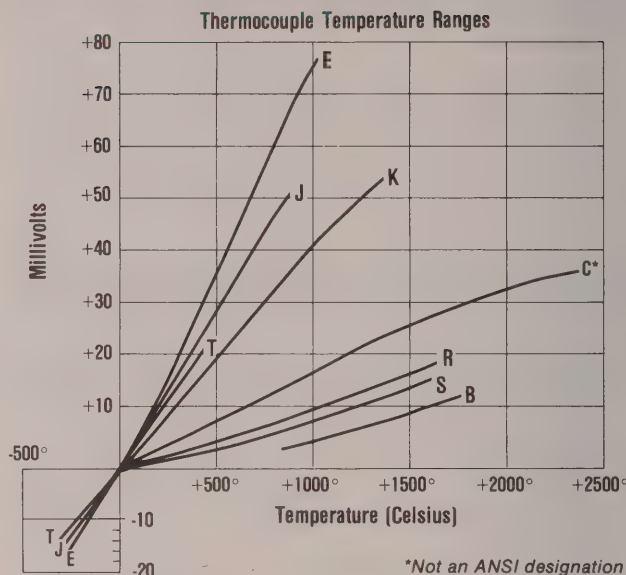
**Type E, Chromel-Constantan.** Range is -270°C to +1000°C. Highest voltage output per degree. For use in oxidizing or inert gas atmospheres. Not for sulphurous, low-oxygen, or reducing atmospheres or in vacuum at high temperatures. Most applications require protective tube or sheath. Color code: Purple plus, red minus.

**Type R & S, Platinum-Rhodium Alloys.** Positive material is a platinum-rhodium alloy; negative is pure platinum. Positive material for Type R is 13% rhodium; Type S is 10% rhodium. Range is 0°C to +1760°C. High resistance to oxidation and corrosion but hydrogen, carbon, sulphur, phosphorus, and metal vapors can contaminate. Should generally be used in non-metallic protective tube. Color code: Black plus, red minus.

**Type B, Platinum-Rhodium Alloys.** Positive is 30% rhodium; negative is 6% rhodium. Range is 0°C to +1820°C. Otherwise like R & S types. Color code: Grey plus, red minus.

**Type C, Tungsten-Rhenium Alloys.** Range is 0°C to +2350°C. For high temperature measurements. Poor oxidation resistance. Should be used in vacuum, hydrogen, inert gas, or reducing environment.

## Thermocouple Linearization



The relationship between the temperature of a thermocouple and its generated voltage is very non-linear. Fluke thermometers linearize the measured signal using a segmented curve-fit algorithm. The 2160- and 2170-Series Thermometers use an LSI chip. The 2190A Thermometer uses a microcomputer.

## Digital RTD Thermometers

A resistance temperature detector (RTD) consists of an element, mounted strain free, having a resistance that varies a known amount as a function of its temperature. An accurate source of current is used to measure its resistance by measuring the voltage-drop across it. The 2180A Digital RTD Thermometer is a very accurate dc voltage measuring instrument that also provides a stable known source of current and has a microcomputer with precise curve-fit algorithms to match several types of RTDs.

Linearization is performed using a segmented, fourth order polynomial curve-fit algorithm in the 2180A Thermometers microcomputer.

## Digital Thermometer Accuracy

Any digital thermometer using contemporary analog-to-digital conversion techniques can only be totally characterized for accuracy by a statement that includes the following error terms. We call such a statement about digital thermometers the *Total Instrument Accuracy* specification.

**NBS or DIN Curve Conformity:** Absolute worst-case deviation over complete sensor span.

**Calibration:**  $\pm 1/2$  digit (resolution) + curve conformity at calibration point.

**Span:** Expressed as percent of reading, °F/°C. Function of reference voltage temperature coefficient.

**Zero:** Temperature coefficient and drift outside auto-zero loop (negligible in Fluke a-d converter).

**Reference Junction:** Expressed in degrees per degree deviation from 25°C (77°F). Consists of linearity error plus temperature coefficient error. For thermocouples only.

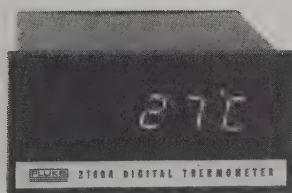
**Noise:** Inherent instrument electrical noise.

**Stability:** Expressed in percent of reading (reference voltage change) + absolute error in degrees (reference junction compensation change).

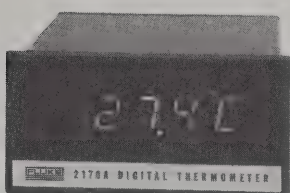
The Fluke *Total Instrument Accuracy* specification includes all of the above error sources and is a direct benefit to a user by providing a clear, concise statement of accuracy in simple terms of °C and °F.

# DIGITAL THERMOMETERS & SYSTEMS

Available through Distributors (See page 248) . . . 2160A/2170A Series Thermometers



2160A

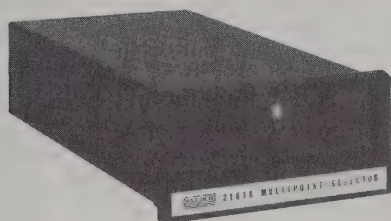


2170A

## 2160A/2170A Panel-Mount Thermometers

The 2160A and 2170A Thermometers are designed to be mounted in a panel. The panel opening required is a rectangle that is only 4.5 cm high by 9.2 cm wide, conforming to DIN Standard 43700. Both thermometers will indicate temperature in degrees Celsius or degrees Fahrenheit and an internal jumper is used to switch from one scale to the other.

The 2160A has a 1°C or 1°F resolution and uses any one of eight thermocouple types (J,K,T,E,R,S,B, or C). The 2170A has a 0.1°C or 0.1°F resolution and uses any one of four thermocouple types (J,K,T, or E). Both the 2160A and 2170A are physically and electrically compatible with the 2161A Multipoint Selector and the 2162A Digital Limit Comparator.



2161A

## 2161A Panel-Mount Multipoint Selector

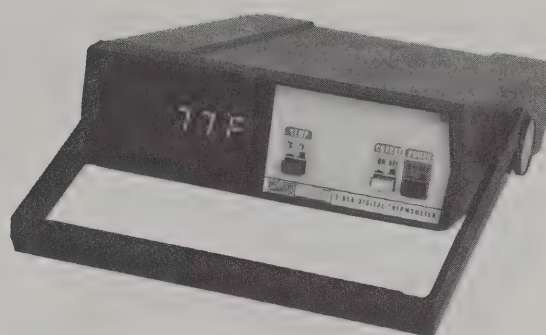
The Model 2161A Multipoint Selector is a panel-mounting, manually switched selector that allows 1 to 10 thermocouple probes of the same type to function as the input to the 2160A, or 2170A or other thermocouple thermometers. Two or more 2161As can be connected in series for monitoring more than ten inputs.



2162A

## 2162A Panel-Mount Limit Comparator

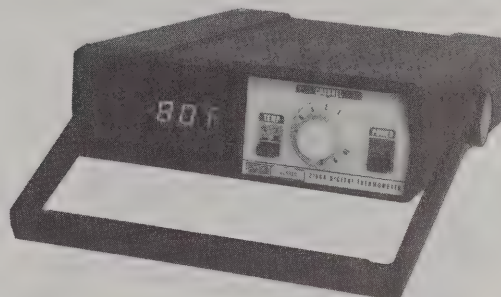
A panel-mounting, single-limit comparator with attached cable and plug compatible with 2160A or 2170A. Front panel thumb-wheel switches allow you to select polarity, four limit digits, and high or low limit. Resolution is  $\pm 1^\circ$ . An out-of-limit reading generates a visual indication and a contact closure. Two 2162As can be connected in parallel for two-limit requirements.



2165A

## 2165A Digital Thermometer

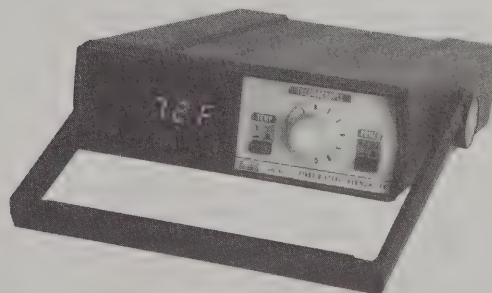
A single-point instrument in a rugged, portable case with specifications identical to the 2160A. It can be equipped with internal rechargeable batteries. Pushbutton controls include power (ON-OFF), temperature scale selection ( $^\circ\text{F}/^\circ\text{C}$ ), and battery charge (ON-OFF). Resolution is 1°F or 1°C.



2166A

## 2166A Multipoint Digital Thermometer

The 2166A is the same basic bench-type instrument as the 2165A but with the capability for monitoring up to 10 thermocouples of the same type. Thermocouple channel selection is by a 10-position front panel rotary switch. Power is either line voltage or external 12V dc (Y2004 Battery Pack has rechargeable batteries). Resolution is 1°F or 1°C.



2168A

## 2168A Multitype Digital Thermometer

The 2168A is a portable, single-point instrument capable of accepting the output from any one of eight thermocouple types.



# DIGITAL THERMOMETERS & SYSTEMS

**2160A/2170A Series Thermometers . . . Available through Distributors (See page 248)**

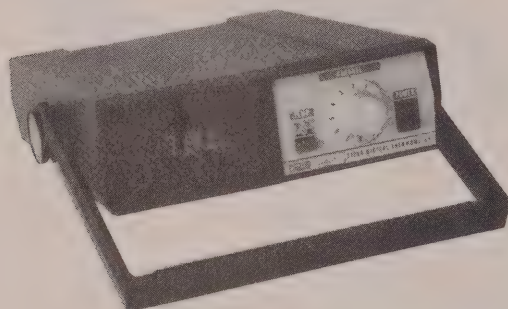
Performance specifications are identical to the 2160A for each thermocouple type. Front panel controls include pushbutton power switch (ON-OFF) and temperature scale selection ( $^{\circ}\text{F}/^{\circ}\text{C}$ ), plus an eight-position rotary switch for selecting thermocouple type. Power is either line voltage or external 12V dc. Resolution is  $1^{\circ}\text{F}$  or  $1^{\circ}\text{C}$ .



**2175A**

## 2175A Digital Thermometer

The 2175A is a single-point instrument in a rugged, portable bench-mount case with the same specifications as the 2170A. It can be equipped with internal rechargeable batteries. Pushbutton controls include a power switch (ON-OFF), temperature scale selection ( $^{\circ}\text{F}/^{\circ}\text{C}$ ), and battery charge. Resolution is  $0.1^{\circ}\text{F}$  or  $0.1^{\circ}\text{C}$ .



**2176A**

## 2176A Digital Thermometer

The 2176A is the same basic bench-type instrument as the 2175A but with the additional capability of monitoring up to 10 thermocouples (of the same type). Thermocouple channel selection is by means of a 10-position front panel rotary switch. Power is either line voltage or external 12V dc (with Y2004 Battery Pack). Resolution is  $0.1^{\circ}\text{F}$  or  $0.1^{\circ}\text{C}$ .

## Option Specifications

### Rechargeable Batteries (-01)

Used in Models 2165A and 2175A for portable operations, and provides a continuous operating time of 8 hours. The internal batteries are recharged from line power in either trickle or full charge mode. They are field-installable at a later date.

### Digital Output Unit (-02)

A field-installable option that provides a parallel BCD digital output equivalent to the displayed measurement data. Output data is solicited by an External Trigger and valid data is insured by Busy and Not Busy outputs. Output is fully buffered TTL/DTL compatible, isolated to 300V. A 6-foot ribbon cable and connector are included.

### Analog Output Unit (-04)

A field-installable assembly which provides an output voltage of 1 mV per degree (Celsius or Fahrenheit). Automatic polarity sensing is provided so that the polarity of the output voltage agrees with the displayed temperature. The output voltage is isolated from the input and referenced to the low terminal of the external voltmeter, strip-chart recorder, etc. A 6-foot pair of wires and connector are included. Linearity is  $\pm 0.5\%$  of full scale.

## Specifications

### Compatible Thermocouple Types:

2160A Series: J, K, T, E, R, S, B, C

2170A Series: J, K, T, E

Measurement Method: Dual-slope integration over a 100 ms period

Drift: None, automatic zero correction

Reading Rate: 2.5 readings per second

Conversion  $^{\circ}\text{C}$  to  $^{\circ}\text{F}$ : Jumper-selectable in panel-mount models.

Switch-selectable on portable models

Input Connections: Screw terminals on isothermal connector

Input Circuit: Two-wire, isolated

Input Impedance: 100 M $\Omega$

Input Current: 500 pA

Source Impedance: 5 k $\Omega$  (5 k $\Omega$  causes  $<0.2^{\circ}\text{C}$  error with K thermocouple)

Maximum Input Voltage: 400V dc or peak ac continuously, between inputs or either input and ground

Maximum Common Mode Voltage: 400V dc or peak ac

Common Mode Rejection:  $\geq 120$  dB at 50, 60, 400 Hz  $\pm 0.1\%$  with 1 k $\Omega$  source impedance unbalance

Normal Mode Rejection:  $\geq 60$  dB at 50, 60, 400 Hz  $\pm 0.1\%$

Overload: Display flashes when input voltage exceeds full-scale temperature range

Open Input: Display flashes to indicate open at input terminals

Response Time:  $\leq 2.0$  second to rated accuracy

### 2160A Series Accuracy Specifications

Thermocouple Type	Applicable Temperature Range $^{\circ}\text{C}$	Maximum Error** ( $\pm^{\circ}\text{C}$ )			Applicable Temperature Range $^{\circ}\text{F}$	Maximum Error** ( $\pm^{\circ}\text{F}$ )		
		Calibration Accuracy	90 Days 20 to 30 $^{\circ}\text{C}$	1 Year 15 to 35 $^{\circ}\text{C}$		Calibration Accuracy	90 Days 68 to 86 $^{\circ}\text{F}$	1 Year 59 to 95 $^{\circ}\text{F}$
J	-200 to 0 0 to 778	1 1	1.5 1	1.5 1.5	-328 to 32 32 to 1432	1.5 1	2 1.5	2.5 2
K	-200 to 0 0 to 1356	1 1	1.5 1.5	2 2	-328 to 32 32 to 2472	2 1.5	2.5 2.5	3 3
T	-200 to 0 0 to 400	1 1	1.5 1	2 1	-328 to 32 32 to 752	1.5 1	2 1.5	3.5 2
E	-200 to 0 0 to 1000	1 1	1.5 1	2 1.5	-328 to 32 32 to 1832	1.5 1	2 2	3.5 2.5
R	0 to 1778	1.5	2.5	3	32 to 3232	2	4	5
S	0 to 1778	1.5	2	3	32 to 3232	2	3.5	4.5
B	533 to 18	1.5	2	2.5	992 to 3352	2	3.5	4.5
C*	0 to 2328	2.5	3.5	4	32 to 3999	4	6	6.5

\* C designates Tungsten-5% Rhenium vs. Tungsten-26% Rhenium

\*\* Max. error includes NBS conformity, calibration, span, zero, reference junction, noise and stability, but not thermocouple errors. Add  $0.1^{\circ}\text{C}$  or  $0.2^{\circ}\text{F}$  for Model 2166A.

# DIGITAL THERMOMETERS & SYSTEMS

Available through Distributors (See page 248) . . . 2160A/2170A Series Thermometers

## 2170A Series Accuracy Specifications

Thermocouple Type	Applicable Temperature Range °C	Maximum Error* (± °C)			Applicable Temperature Range °F	Maximum Error* (± °F)		
		Calibration Accuracy	90 Days 20 to 30 °C	1 Year 15 to 35 °C		Calibration Accuracy	90 Days 68 to 86 °F	1 Year 59 to 95 °F
J	-99.9 to 0 0 to 777.9	0.5 0.4	1 0.7	1.2 1.1	-99.9 to 32 32 to 999.9	0.9 0.7	1.6 1.2	2.1 1.6
K	-99.9 to 0 0 to 999.9	0.7 0.5	1.2 1.1	1.5 1.4	-99.9 to 32 32 to 999.9	1.1 1	2.0 1.4	2.6 1.8
T	-99.9 to 0 0 to 400	0.6 0.4	1 0.6	1.6 0.9	-99.9 to 32 32 to 752	0.9 0.6	1.7 1	2.9 1.5
E	-99.9 to 0 0 to 999.9	0.6 0.5	1 1	1.7 1.4	-99.9 to 32 32 to 999.9	0.9 0.8	1.7 1.3	3.0 1.8

\* Max. error includes NBS conformity, calibration, span, zero, reference junction, noise and stability, but not thermocouple errors. Add 0.1° C and 0.2° F for Model 2176A.

**External DC Source:** 2166A, 2168A, and 2176A 11 to 15V dc at 400 mA. Y2004 recommended

**Size:** (2165A, 2166A, 2168A, 2175A and 2176A), 6.4 cm H x 21.7 cm W x 25.2 cm D (2.52 in H x 8.55 in W x 9.9 in D)

**Size:** (2160A and 2170A) conforms to DIN standard 43700. 4.8 cm H x 9.6 cm W x 20.5 cm D (1.88 in H x 3.78 in W x 8.05 in D). Panel cutout is 9.2 cm x 4.5 cm (3.62 in x 1.77 in)

**Type of Display:** LED

**Shock and Vibration:** Meets requirements of MIL-Std-810

**Ambient Temperature:** 0°C to 50°C, operating; -40°C to 60°C with batteries, -40° to 75°C without batteries, non-operating

**Relative Humidity:** ≤90% from 0°C to 35°C, ≤80% to 50°C, non-condensing

**Line Operation:** 115V ac ±10%, 50 to 440 Hz, 8W (bench), 4W (panel). 100V ac and 230V ac versions are also available

**Battery Operation:** Option -01 for the 2165A and 2175A operates eight hours on a full charge. Y2004 Battery Pack for 2166A, 2168A, and 2176A operates six hours on a full charge, typically

### Weight

**2165A and 2175A:** 1.19 kg (2.63 lb) without batteries, 1.79 kg (3.95 lb) with batteries

**2166A, 2168A, 2176A:** 1.35 kg (3 lb)

**2160A, 2170A:** 0.74 kg (1.63 lb)

**Warranty Period:** One year

**Included:** Instruction manual, power cord. Thermocouple or thermocouple probe not included

## Models

January 1985 prices

2160A*	Thermometer (panel-mount)	\$440
2161A	Multipoint Selector (panel-mount)	200
2162A	Digital Limit Comparator (panel-mount)	370
2165A*	Thermometer	575
2166A*	Thermometer (10 points)	680
2168A	Thermometer (8 types)	810
2170A*	Thermometer (panel-mount)	480
2175A*	Thermometer	675
2176A*	Thermometer (10 points)	800

\* Specify thermocouple type to be used. Thermocouples or probes not included.

## Options

2160A-01*	Rechargeable Batteries	95
2160A-02**	Digital Output (w/cable)	180
2160A-04**	Analog Output (w/cable)	235

\*For 2165A and 2175A only

\*\*Mutually exclusive

## Accessories

See next page and page 232

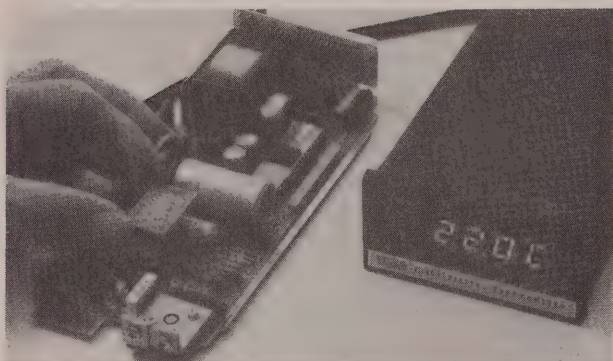
## After-Warranty Service (See page 227)

SC1-2160A,	per 90-day interval	44
SC1-2161A,	per 90-day interval	28
SC1-2162A,	per 90-day interval	36
SC1-2165A,	per 90-day interval	48
SC1-2166A,	per 90-day interval	56
SC1-2168A,	per 90-day interval	68
SC1-2170A,	per 90-day interval	52
SC1-2175A,	per 90-day interval	52
SC1-2176A,	per 90-day interval	60



# DIGITAL THERMOMETERS & SYSTEMS

2160A/2170A Series Thermometers . . . Available through Distributors (See page 248)

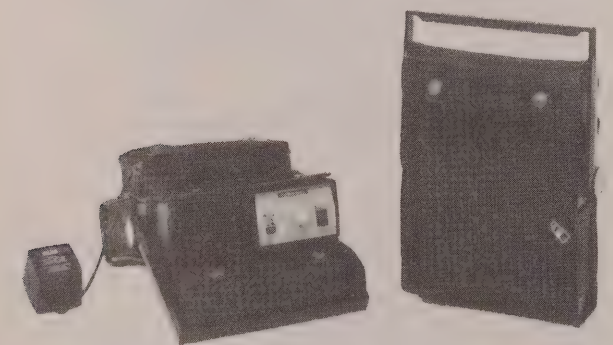


## Thermocouple Type Conversion Kits

Your 2160- or 2170-Series Digital Thermometer may be equipped to work with only one type of thermocouple at a time. But it is very simple to convert it to be used with a different type thermocouple with an inexpensive conversion kit. Section II of your instruction manual tells how.

A conversion kit for a J,K,T, or E type thermocouple may be installed in any 2160- or 2170-Series Thermometer. In addition, a kit for a type R,S,B, or C may be installed in 2160 Series (but not the 2170 Series).

NBS Type	Conversion Kit No.	NBS Type	Conversion Kit No.
J	2160A-7016 \$35	R	2160A-7012 \$35
K	2160A-7017 35	S	2160A-7013 35
T	2160A-7018 35	B	2160A-7014 35
E	2160A-7019 35	C	2160A-7015 35



Y2004

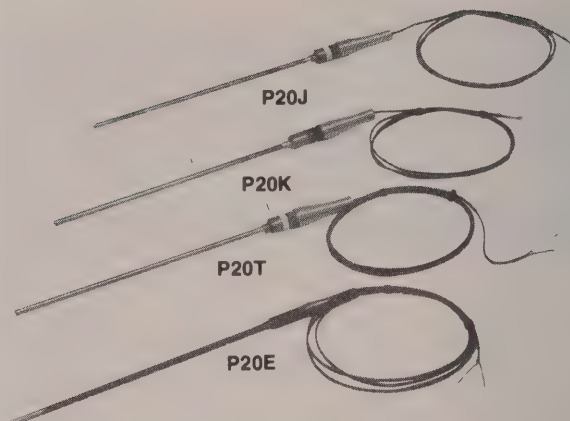
Y2005

## Y2004 & Y2005 Case and Battery Pack

The Y2004 consists of a case, 12-volt battery pack, and charger for use with the 2166A, 2168A, and 2176A. The Y2005 is a case only for any bench model 2160- or 2170-Series Thermometer. The Y2004 is especially recommended for the 2166A, 2168A, and 2176A Digital Thermometers because those models are not available with a self-contained rechargeable battery pack but have external 12-volt power connectors.

Typical operating time with batteries having a full charge is six hours. Recharge time at 25°C is approximately 15 hours.

Y2004 Case/Battery Pack & Charger	\$195
Y2005 Case	45



## P20-Series Thermocouple Probes

These probes are ANSI Standard accuracy general purpose immersion type probes. They have sheaths 6-inches long by 1/8-inch diameter made of INCONEL.

The thermocouple lead wire is three feet long and its insulation will withstand temperatures up to 480°C continually. Inside the sheath, the wires are insulated with magnesium oxide but are grounded to the sheath at the junction. They are particularly intended for use with Fluke 2190A Digital Thermometers and the 2160- and 2170-Series Digital Thermometers.

Type	Useful Range
P20J \$60	-150° to 875°C
P20K 60	-150° to 1260°C
P20T 60	-150° to 400°C
P20E 60	-270° to 1000°C



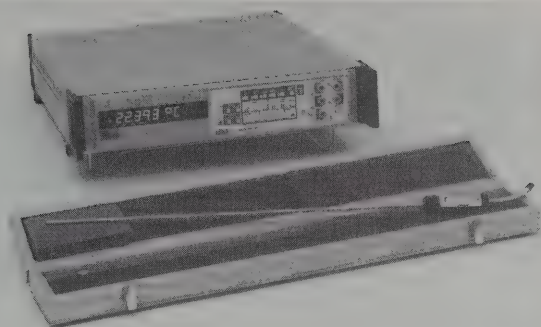
## Thermocouple Probe Extender Connectors

Matching thermocouple connectors should be used to extend length of leads when using thermocouple probes. Connectors and 100-foot lengths of #20 AWG thermocouple wire are available. Connectors are made of thermocouple material type and should match the type of thermocouple wire.

NBS Type	Probe Type	Mating Connectors	Thermocouple Wire (100 ft)
J	P20J	Y8114 \$15	Y8110 \$65
K	P20K	Y8115 15	Y8111 110
T	P20T	Y8116 15	Y8112 110
E	P20E	Y8117 15	Y8113 110

## DIGITAL THERMOMETERS

8520A/PRT



8520A/PRT

## Precision — with RTDs or Thermocouples

- -200°C to +350°C (ITS 68) range
- $\pm 0.010^\circ\text{C}$  accuracy -100°C to +100°C
- $0.001^\circ\text{C}$  resolution
- Reading storage memory
- IEEE-488 interface
- Onboard computational programs
- Full DMM capability

The 8520A/PRT is a temperature measurement system consisting of a Rosemount® 162N Platinum Resistance Thermometer (PRT) and a Fluke 8520A 5½-Digit Precision Digital Multimeter. The 8520A contains a built-in linearization program customized to match the calibration curve of the specific PRT supplied. Temperature is indicated directly in either °C, °F or K with 0.001 degree resolution.

The system provides a fast, low-cost way of making extremely accurate temperature measurements, or calibrating temperature measurement instruments, in the range of -200°C to +350°C. Systems using four-terminal resistance bridges are much more time-consuming to use, require greater expertise, are limited in their applications, and are far more costly.

Measurements are repeated approximately once per second, making it possible to detect and track fast temperature changes, something impractical to try to do with balance bridges.

## 162N PRT Characteristics

All PRTs exhibit hysteresis during temperature cycling, as with going from room temperature to boiling and back. The 162N has a hysteresis of less than 0.001% of the temperature span. That is less than 1 mK ( $0.001^\circ\text{C}$ ) for a  $100^\circ\text{C}$  span, less than 6 mK for the entire thermometer range. This quality is not achievable in any industrial PRT.

Errors due to a change in ice-point resistance can be detected using a standard 100-ohm resistor (supplied), and the change can be compensated easily by changing the gain factor in a memory register of the 8520A. Such compensation is completely effective near  $0^\circ\text{C}$ , least effective near  $-110^\circ\text{C}$  and  $+240^\circ\text{C}$ , but predictable as a worst-case error at all temperatures within the range of  $-200^\circ\text{C}$  to  $+350^\circ\text{C}$ .

## 8520A Characteristics

The 8520A Digital Multimeter is compatible with IEEE-488 instrument systems and has both built-in and optional math power for a wide range of R&D and ATE applications other than temperature measurement and calibration. See page 15 for more information.

Rosemount® is a trademark of Rosemount, Inc.

## Accuracy

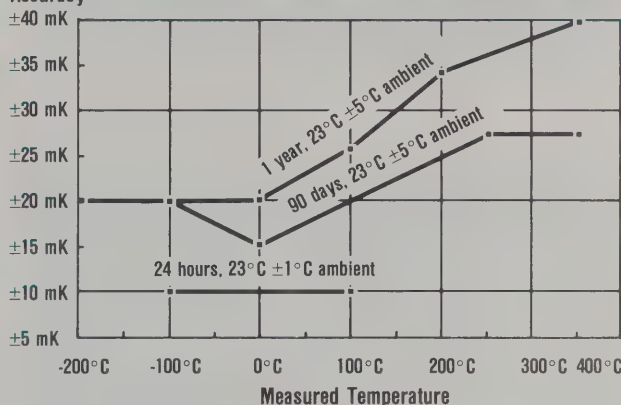
The temperature measurement accuracy of the 8520A/PRT system is shown graphically in the accompanying chart. Because accuracy depends on the stability characteristics of the 8520A as a function of both ambient temperature and time, 24-hour, 90-day, and 1-year accuracy curves are shown. The kind of accuracy you need will determine how often the 8520A should be calibrated.

The stability characteristics of the PRT are also very important and are influenced by time, how carefully it is used, and the kind of use it gets.

The 162N Probe is calibrated in liquid baths. No significant error due to self-heating will occur when measuring the temperature of liquids. A  $+12\text{ mK}$  error should be expected when measuring the temperature of gases.

## Specifications

## Accuracy



Probe Sheath: INCONEL-X750™, 5.6 mm (0.219 in) diameter, 48 cm (19 in) length

Connector: Mates with 8520A input

Power: 100, 120, 220, or 240V ac,  $\pm 10\%$ , 50 to 60 Hz,  $\leq 50\text{W}$

Size: 8.9 cm H x 47.7 cm L x 43.2 cm W ( $3\frac{1}{2}$  in H x 18 in L x 17 in W)

Weight: 9.56 kg (21 lb)

## Model

January 1985 prices

8520A/PRT ..... \$6195

## Option

8520A-010 Extended Software Package ..... 500

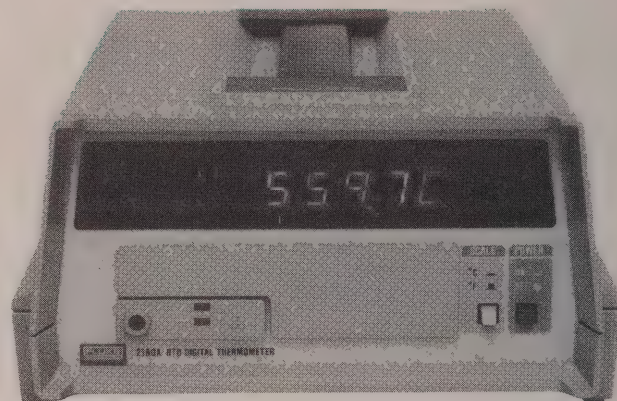


# DIGITAL THERMOMETERS

## 2180A/2189A/2190A



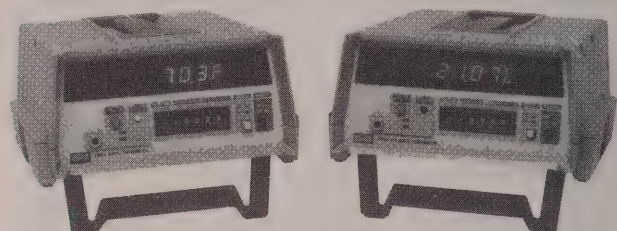
2189A Thermometry System



2180A without Option -006

Output Option -002 and Limits Option -006 are usable with any of the three thermometers. Other accessory items electronically connect and stack and latch to the 2180A or 2190A. These include manual multipoints, multiple alarms, a battery pack, and a thermocouple thermometer calibrator. Some are also practical to use with the 2189A.

For automatic scanning, see the section on the 2300A Scanner. A 2020A or 2030A Printer allows you to permanently store data when used with a 2180A or 2190A configured with an output option. Portable temperature logging is available with the factory-tested Temperature Logging Systems — 2382A, 2383A, 2392A, or 2393A.



2190A/2180A with Option -006

### 2180A/2189A/2190A

- 0.01° resolution for the 2180A and 2189A and 0.1° resolution for the 2190A
- Capable of running off of 12V dc or ac line power
- Designed to be integrated with a wide variety of instruments and accessories through an integral latching system
- °C or °F is selectable via a front panel switch
- A full five digit LED display
- An analog/digital output option is available
- The limits option allows peak and valley memory, alarms and delta
- The 2189A consists of a 2180A and a matched platinum RTD probe for greater accuracy
- Six different RTD types are switch selectable. Four platinum, one nickel, one copper (2180A only)
- Ten different thermocouple linearizations are supported including two DIN standards (2190A only)

Fluke's most accurate and versatile general purpose digital thermometers are the 2180A and 2189A for RTDs and the 2190A for thermocouples. State-of-the-art accuracy teams with a large family of options and accessories to let you make precision temperature measurements in the lab or out in the field.

The 2180A RTD Digital Thermometer lets you switch-select one of six different types of RTDs, four platinum, one nickel, and one copper. Resolution is 0.01°.

The 2189A Thermometry System consists of a 2180A that is factory-matched to a precision Y2039 Platinum RTD Probe.

The 2190A Thermocouple Digital Thermometer supports ten different thermocouple types, including two that comply to European DIN standards. Resolution is 0.1°. Take your choice from three different standard combinations of thermocouple types.

Each thermometer features a bright, high resolution LED display with pushbutton selection of Fahrenheit or Celsius readings. Each is capable of being run from either ac line power or external 12V dc, for field portability.

### Limits Option (-006)

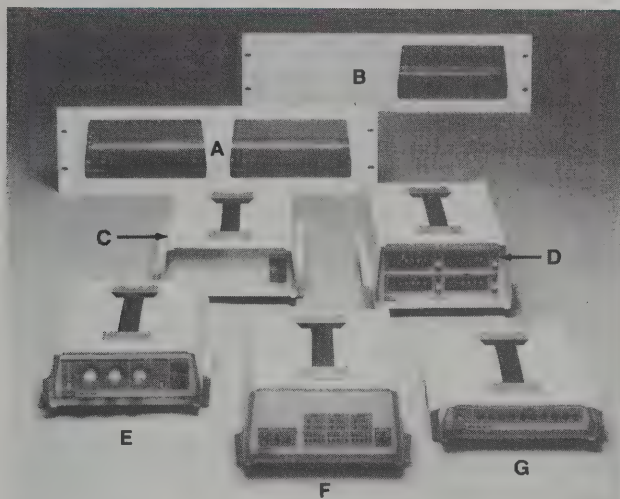
This option adds three powerful functions to the 2180A and 2190A Thermometers: Alarms, Peak Memory, and Delta. The Alarms function lights an indicator and closes a relay to activate external devices whenever a preset maximum or minimum set-point is exceeded. Peak Memory stores the highest and lowest temperature readings for later recall. And Delta automatically subtracts a thumbwheel setting from the actual measurement and displays the difference.



## DIGITAL THERMOMETERS

2180A/2189A/2190A

## A Family of Accessories



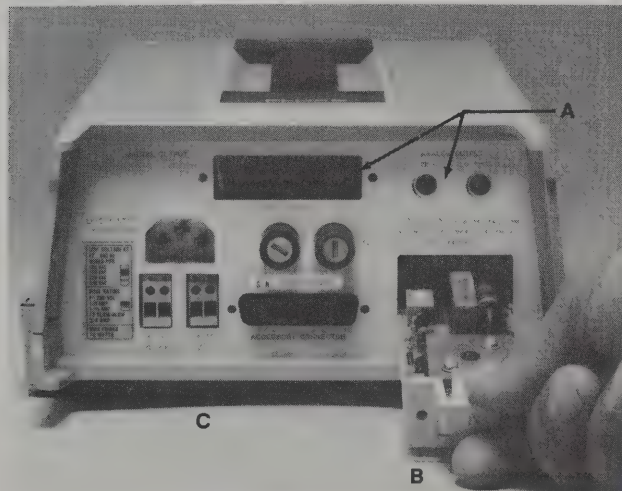
A — Y2001 Multipoint  
B — Y2010 Rack Adapter  
C — Y2009 Battery Pack  
D — Y2002 Alarms Output

E — Y2003 Calibrator  
F — 1120A Translator  
G — Y2000 Multipoint

## Output Option (-002)

For recording temperature measurements with a 2180A or 2190A, you can get Output Option -002. It provides both an analog output for chart recorders and a digital output for printers or computers, and may be installed in the field. The digital output is available in four forms, depending on connector pins and cabling used: Parallel ASCII, RS-232-C, TTY current loop, and IEEE-488 (using the Fluke 1120A Translator). The Y2026B RS-232-C Cable Adapter is available to convert the 36-pin PTI connector on the option to a standard 25-pin RS-232-C connector, or the user can wire his own cable to the connector provided.

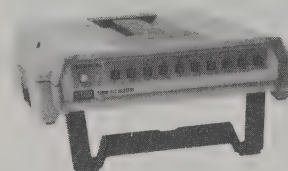
Option -002 is required when the thermometer is being used with a Fluke 2020A-004 or 2030A Printer unless a 2300A Scanner is used.



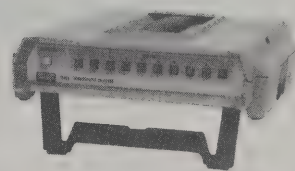
Rear view of 2190A showing the (A) Output Option -002 Connector, (B) Y2030 Thermocouple Input Module, and (C) Limits Option -006 Relay Output.

## Multipoint Selector (Y2000 &amp; Y2001)

The Y2000 RTD Multipoint Selector (for the 2180A) and the Y2001 Thermocouple Multipoint Selector (for the 2190A) increase the number of points your thermometer can monitor. Connect up to ten sensors to each multipoint selector. Cascade up to ten multipoint selectors for up to 100 measurement points — all using a single 2180A or 2190A Thermometer. Both units have ten pushbuttons to easily access a specific measurement point. To measure or monitor more than one *type* of RTD or thermocouple, take advantage of internal switching. This allows you to monitor five sensors of one type, five of another. With Output Option -002 installed, the channel number is sent to your printer or computer, too.



Y2000



Y2001

## Multiple Limits and Alarms (Y2002)

The Y2002 Alarms Output accessory uses four independent comparator circuits for on/off control as well as alarms. Four sets of thumbwheel switches select a high- or low-limit mode, polarity, and the actual limit value. Each comparator circuit signals out-of-limit conditions via an LED and a reed relay (latching or non-latching).

## Thermometer Calibration (Y2003)

The Y2003 Thermometer Calibrator and 2190A Digital Thermocouple Thermometer can be used together to check the accuracy of a thermocouple or millivolt-measuring or recording instrument.

Accurate and completely portable, the Y2003-2190A combination provides a variable voltage output from -10 mV to +90 mV. The output voltage simulates a thermocouple output, so that the reading on the 2190A Thermometer can be compared with a corresponding reading on any other thermocouple thermometer, either analog or digital. In addition, the Y2003 and 2190A can be used to calibrate millivolt chart recorders and digital or analog indicators measuring to 90 mV. Besides being used as a portable calibration system, the Y2003 can be used as a battery pack for the 2190A.



The 2190A/Y2003 Portable Calibration System



# DIGITAL THERMOMETERS

## 2180A/2189A/2190A

### Battery Pack (Y2009)

The Y2009 Battery Pack is a rechargeable, self-contained 12V dc nickel-cadmium supply for up to five hours of continuous operation. An indicator light tells you when the batteries are low, while an automatic out-off prevents damage to the cells from excessive discharge.

### IEEE-488 Bus Translator (1120A)

The Fluke 1120A Translator configured with Option 2XXXA-522 provides a link to the IEEE-488 bus. Connect either a 2180A or a 2190A to the 1120A and you'll have an inexpensive bus-compatible system. See page 218 and following sections for more information.

### Specifications

#### 2190A Thermocouple Thermometer Specifications

**Thermocouple Types:** Five, switch selectable. Which thermocouple types depends on your choice of microcomputer type. See Accuracy chart below

**Resolution:** 0.1°C or °F

**Input Connection:** 2 wires on screw terminal isothermal block

**Max Source Impedance:** 2 k $\Omega$

**Overrange Detection:** Flashing display

**Open Circuit Detection:** Source impedance of 3 k $\Omega$  or more causes a flashing "OC"

#### 2190A Accuracy\*

Thermocouples		Maximum Error*					
		$\pm$ Degrees C			$\pm$ Degrees F		
		At Cal	90 Days 20°C to 30°C	1 Year 15°C to 35°C	At Cal	90 Days 68°F to 86°F	1 Year 59°F to 95°F
<b>Type 1</b>							
J	-128 to 0	0.18	0.19	0.21	0.20	0.23	0.26
	0 to 900	0.18	0.31	0.36	0.20	0.47	0.58
K	-132 to 0	0.18	0.19	0.21	0.30	0.33	0.37
	0 to 1350	0.18	0.39	0.47	0.30	0.72	0.87
T	-243 to 0	0.18	0.20	0.22	0.30	0.35	0.39
	0 to 400	0.18	0.22	0.25	0.30	0.41	0.46
R	0 to 1708	0.31	0.59	0.70	0.47	1.01	1.20
C**	0 to 2471	0.18	0.60	0.75	0.30	1.11	1.37
<b>Type 2</b>							
J	-128 to 0	0.18	0.19	0.21	0.20	0.23	0.26
	0 to 900	0.18	0.31	0.36	0.20	0.47	0.58
K	-132 to 0	0.18	0.19	0.21	0.30	0.33	0.37
	0 to 1350	0.18	0.39	0.47	0.30	0.72	0.87
E	-252 to 0	0.18	0.20	0.22	0.30	0.35	0.40
	0 to 1000	0.18	0.33	0.39	0.30	0.61	0.72
R	0 to 1708	0.31	0.59	0.70	0.47	1.01	1.20
S	0 to 1685	0.22	0.50	0.60	0.38	0.92	1.10
<b>Type 3</b>							
J	-100 to 0	0.18	0.19	0.20	0.30	0.32	0.36
	0 to 760	0.18	0.28	0.33	0.30	0.52	0.61
K	-50 to 0	0.18	0.18	0.20	0.20	0.22	0.25
	0 to 1372	0.18	0.39	0.48	0.20	0.63	0.78
T	-200 to 0	0.18	0.20	0.21	0.30	0.34	0.38
	0 to 400	0.18	0.22	0.25	0.30	0.41	0.46
B	420 to 1815	0.21	0.52	0.62	0.37	0.95	1.15
R	140 to 1700	0.18	0.46	0.46	0.20	0.74	0.93

\* Total instrument accuracy. Does not include Thermocouple errors such as non-conformity to standard curve.

\*\* C designates Tungsten-5% Rhenium vs. Tungsten-26% Rhenium.

\*\*\* DIN is a European Standard.

#### 2180A RTD Thermometer Specifications

**RTD Types:** 100 $\Omega$  Pt, 385 (DIN), 390, 3916, or 392; 100 $\Omega$  Ni (DIN); 10 $\Omega$  Cu; 0 to 999 $\Omega$  resistance — switch-selectable

**Resolution:** 100 $\Omega$  Pt RTDs: 0.01°, autoranging to 0.1° above 204°C; 100 $\Omega$  Ni RTDs: 0.01°, autoranging to 0.1° above 93°C; 10 $\Omega$  Cu RTDs: 0.1°

**Input Connection:** 4-wire screw terminals. Terminals accept 3-wire and 2-wire RTDs at reduced accuracy

**RTD Matching:** User-performed potentiometer adjustment matches the 2180A to user's RTD to compensate for variations in lead length and resistance at 0°C

**Lead Resistance:** 4-wire: 200 $\Omega$  max per lead for both 100 $\Omega$  and 10 $\Omega$  RTDs; 3-wire: 2 $\Omega$  max per lead for 100 $\Omega$  RTDs, 0.18 $\Omega$  max per lead for 10 $\Omega$  RTDs; 2-wire: 0.9 $\Omega$  max per lead for 100 $\Omega$  RTDs, 0.09 $\Omega$  max per lead for 10 $\Omega$  RTDs

**Lead Resistance Error:** 4-wire: no error; 3-wire 100 $\Omega$  RTDs: 0.012° per degree per ohm; 3-wire 10 $\Omega$  RTDs: 0.12° per degree per ohm; 2-wire 100 $\Omega$  RTDs: 0.025° per degree per ohm; 2-wire 10 $\Omega$  RTDs: 0.25° per degree per ohm

#### 2180A Linearizations (Type 2)\*

RTD Type	Linearization Coefficients		
100 $\Omega$ 385 Pt	DIN** 43760 Table		
100 $\Omega$ 390 Pt	ALPHA*	=	0.0038994
	DELTA*	=	1.494
	A4*	=	-0.265668 x 10 <sup>-4</sup>
	C4*	=	-0.205984 x 10 <sup>-11</sup>
100 $\Omega$ 3916 Pt	ALPHA*	=	0.003916
	DELTA*	=	1.505
	A4*	=	-0.099668 x 10 <sup>-5</sup>
	C4*	=	-0.271142 x 10 <sup>-12</sup>
100 $\Omega$ 392 Pt	ALPHA*	=	0.00339221
	DELTA*	=	1.493
	A4*	=	-0.38668 x 10 <sup>-5</sup>
	C4*	=	+0.192912 x 10 <sup>-13</sup>
100 $\Omega$ 617 Ni	DIN** 43760 Table		
10 $\Omega$ *** Cu	R0	=	9.042 Ohms
	R25	=	10.005 Ohms
	ALPHA	=	0.004260

\* See IPTS 68 equations in NBS Monograph 126. Type 1 no longer available.

\*\* European Standard.

\*\*\* Contact factory for information on the 2180A/AT for 10 ohm, 3 wire applications

## DIGITAL THERMOMETERS

2180A/2189A/2190A

## 2180A Accuracy (Type 2)\*

RTDs		Maximum Error*					
		±Degrees C			±Degrees F		
Type	Applicable Portion of Temperature Range °C	At Cal	90 Days 20°C to 30°C	1 Year 15°C to 35°C	At Cal	90 Days 68°F to 86°F	1 Year 59°F to 95°F
100Ω	-190 to 0	0.043	0.089	0.112	0.076	0.161	0.203
	0 to 204	0.043	0.132	0.173	0.076	0.239	0.314
385	-190 to 0	0.11	0.12	0.14	0.18	0.21	0.24
Pt	0 to 750	0.11	0.26	0.37	0.18	0.46	0.62
100Ω	-200 to 0	0.009	0.055	0.078	0.015	0.100	0.142
	0 to 204	0.009	0.098	0.139	0.015	0.177	0.252
390	-200 to 0	0.08	0.10	0.11	0.13	0.16	0.19
Pt	0 to 750	0.08	0.23	0.32	0.13	0.41	0.57
100Ω	-200 to 0	0.040	0.086	0.109	0.071	0.156	0.198
	0 to 204	0.040	0.13	0.171	0.071	0.234	0.309
3916	-200 to 0	0.11	0.12	0.14	0.17	0.21	0.24
Pt	0 to 750	0.10	0.26	0.34	0.17	0.46	0.62
100Ω	-200 to 0	0.008	0.055	0.078	0.014	0.099	0.141
	0 to 204	0.009	0.098	0.139	0.014	0.177	0.252
392	-200 to 0	0.08	0.10	0.11	0.12	0.16	0.19
Pt	0 to 750	0.08	0.23	0.32	0.12	0.41	0.57
100Ω	-60 to 0	0.129	0.157	0.172	0.230	0.282	0.308
	0 to 93	0.129	0.176	0.199	0.231	0.317	0.359
617	-60 to 0	0.19	0.20	0.21	0.33	0.35	0.35
Ni	0 to 177	0.19	0.22	0.25	0.33	0.39	0.44
10Ω	-75 to 0	0.16	0.18	0.19	0.27	0.31	0.34
Cu	0 to 150	0.16	0.20	0.23	0.27	0.35	0.41
Ohms	0 to 196.99	0.005	0.042	0.059	All Units In Ohms		
	0 to 999.99	0.05	0.22	0.31			

NOTE: Shaded area is 0.01° resolution; unshaded area is 0.1° resolution

\* Total instrument accuracy. Does not include RTD probe errors. Valid for 4-wire RTDs only. Microcomputer Type 1 no longer available.

## 2189A Thermometry System Specifications

Includes Platinum RTD Probe Y2039.

## Maximum System Error (±°C)

Temperature °C	At Calibration	90 Days 18°C-28°C Ambient	1 Year 18°C-28°C Ambient
----------------	----------------	---------------------------------	--------------------------------

## Low Temperature Range...

-183	(1)	(1)	(1)
-50	0.04	0.08	0.11
0	0.03	0.07	0.09
50	0.05	0.10	0.13
100	0.07	0.12	0.16
150	0.08	0.15	0.20
200	0.09	0.17	0.23

## High Temperature Range... Periodic probe exposure\*

204	0.14	0.25	0.27
300	0.18	0.32	0.33
400	0.21	0.39	0.40
480	0.29	0.48	0.50

(1) The system operates down to -183°C but the probe calibration is not verified below -50°C. It is estimated that the accuracy below -50°C is the same as the accuracy at an equal temperature in the positive range. Low temperature calibrations are available as a special.

\*Accuracy above 200°C is based on the user performing an Ice Point adjustment in accordance with the following schedule:

Probe Exposure  
Temperature Range  
200°C to 350°C  
350°C to 480°C

Total Exposure Time  
Before Adjustment  
500 hours  
250 hours

Exposure of the Y2039 at high temperatures for long periods of time may cause the probe to change its characteristics and require the accuracy specifications to be degraded. For example, there is a 20% probability that exposure at 480°C for 500 hours will require degrading. It is easy for the user to determine if degrading is necessary by measuring the Ice Point resistance of the probe. The 2189A Instruction Sheet explains this degrading procedure.

## Option Specifications

## Output Option (-002)

## Analog Output

Type: Linearized and isolated

Voltage: 1.0 mV/°C or °F from -425 mV to 4.5V, 5 mA max

Temperature Coefficient: 200 ppm/°C from 25°C

Noise: ≤100 μV at 100 Hz bandwidth

Accuracy: ±0.1% of reading ±1 mV

Drift: 200 μV/°C from 25°C

Overload or Open Circuit: Zero volts via banana jacks

## Digital Output

Types: Four, E.I.A. Standard RS-232-C, TTY current loop, parallel ASCII, and Fluke PTI

Connector: 36-pin AMP "Champ"

Serial Baud Rates: 110, 150, 300, 600, 1200, 2400, 4800, or 9600, switch-selectable

RS-232-C Signals: Transmitted Data, Request to Send, Clear to Send, Data Set Ready, Signal Common

Parallel ASCII Signals: Data: 8 lines; Instrument Address: 4 lines; Address Valid; Data Valid; Acknowledge; Ground; +5V

TTY Current Loop Signals: Source and controlled sink, 20 mA

Out-of-Limit Signals: Exclamation point transmitted with Option -006 only; not with Y2002

## Limits Option (-006)

Limits Function: Lights LED and activates Form A (SPST) reed relay when thumbwheel setpoint is exceeded. Reed relay rated 10 VA, 184V dc or 130V ac rms max, 0.5A max, resistive. Selectable either low (≤) or high (≥).

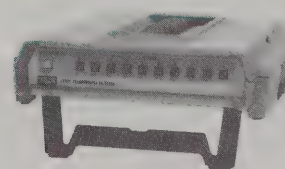
Min/Max Function: Continuously stores Min and Max temperature

Delta Function: Displays difference between thumbwheel setpoint and actual temperature

Thumbwheels: 6, for function, sign, and setpoint (±9999). Setpoint resolution is 1°

## Accessory Specifications

## Y2000 RTD Multipoint Selector



Y2000

Channels: Ten per Y2000, up to ten Y2000s per 2180A. Channel number sent to printer or computer when Output Option -002 is used

RTD Types: Same as 2180A. Two types selectable per Y2000

Power: Supplied by 2180A

Interfacing: Attached 46-cm cable plugs into rear of 2180A or Y2002.

Receptacle accepts cable chained from other Y2000s

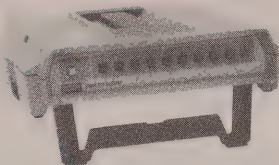
Size and Weight: Style A PTI case, 1.4 kg (3.09 lb)



# DIGITAL THERMOMETERS

## 2180A/2189A/2190A

### Y2001 Thermocouple Multipoint Selector



Y2001

**Channels:** Ten per Y2001, up to ten Y2001s per 2190A. Channel number sent to printer or computer when Output Option -002 is used

**Thermocouple Types:** Same as 2190A. Two types per Y2001

**Maximum Voltage Between Channels:** 125V ac rms

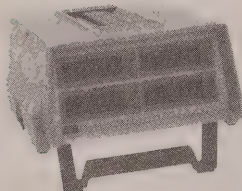
**Power:** Supplied by 2190A

**Interfacing:** Attached 46-cm cable plugs into rear of 2190A or Y2002.

Receptacle accepts cable chained from other Y2001s

**Size and Weight:** Style A PTI case, 1.6 kg (3.53 lb)

### Y2002 Alarms Output



Y2002

**Limit Selections:** Four sets of thumbwheels. Each set selectable as a  $\pm 9999^\circ$  high- or low-limit setpoint

**Alarm Indication:** LED and reed relay — one for each limit setpoint

**Relay Rating:** Form C (SPDT), 230VA, 184V dc or 130V ac rms max, 2A max resistive, selectable latching or non-latching

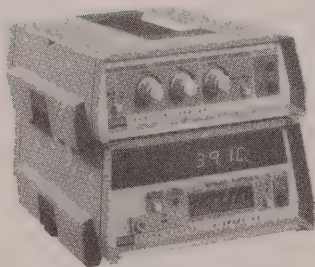
**Power:** Supplied by 2180A or 2190A

**Interfacing:** Attached 46-cm cable plugs into rear of thermometer.

Receptacle accepts cable from Y2000 or Y2001

**Size and Weight:** Style C PTI case, 1.8 kg (3.97 lb)

### Y2003 Thermocouple Calibrator and Battery Pack



The 2190A/Y2003  
Portable Calibration System

**Thermocouple Types:** Same as 2190A

**Output Voltage:** -10 mV to +90 mV, adjustable. Applied at input terminals of 2190A and thermocouple thermometer of less accuracy to be calibrated

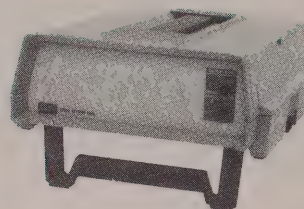
**Adjustments:** Coarse, fine and offset

**Battery Pack:** Same specifications as Y2009

**Interfacing:** Attached 46-cm cable plugs into rear of 2190A

**Size and Weight:** Style B PTI case, 2.6 kg (5.74 lb)

### Y2009 Rechargeable Battery Pack



Y2009

**Output:** 12V dc, 750 mA max

**Battery:** Ten 1/2-D-size cells in drip-proof case

**Operating Time:** 5 to 6 hours typical at 25°C on full charge when connected to 2180A or 2190A

**Recharge Time:** 16 hours typical at 25°C

**Charger:** Built-in on-off switch, low-battery automatic discharge cut-off

**Output Connectors:** Rear panel screw terminal block

**Operating and Storage Temperature:** 0°C to 40°C

**Power:** 100, 120, 220, or 240V ac  $\pm 10\%$  selectable, 50 to 400 Hz; 10W, typical

**Size and Weight:** Style B PTI case, 2.5 kg (5.52 lb), typical

### Y2022 Thermometer Calibration Divider (D in Picture)

**Function:** Either precision resistor or voltage divider ( $\pm 10$  or  $\pm 100$ )

**Input Voltage:** 0-10V dc

**Output Impedance:** 100 $\Omega$

**Precision Resistor:** 100 $\Omega \pm 0.01\Omega$ , temp coefficient 5 ppm

### Y2024 3-Module Power Cord (E in Picture)

Connects three PTI-family instruments or accessories to single 120V ac power outlet

### Y2026B RS-232-C Cable Adapter (C in Picture)

**Function:** Routes RS-232-C signals from 36-pin PTI connectors to 25-pin RS-232-C connectors

**Connections:** Two 36-pin PTI connectors (M and F), two 25-pin RS-232-C connectors (M and F). Y7203 cable supplied

**RS-232-C Pin Selections:** Slide switches. Select TD on pin 2 or 3; DTR, DSR and CTS, through or pulled up; Scanner busy, through or to CTS

### Y2030 Plug-in Module (H in Picture)

Extra plug-in units for 2190A thermocouples. Leave attached to input wire-pair for easy interchange of thermocouple inputs.

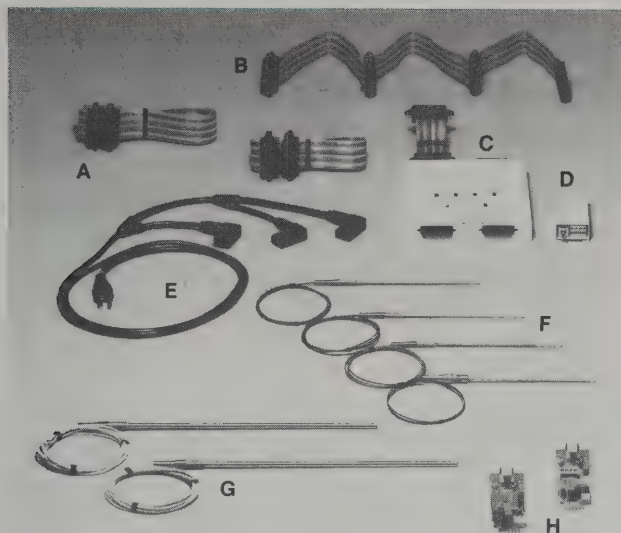
### Y2031 Plug-in Module (H in Picture)

Extra plug-in unit for 2180A RTDs. Leave attached to input wires for easy interchange of RTD inputs.

## DIGITAL THERMOMETERS

2180A/2189A/2190A

## A Family of Accessories



Small accessories shown are: (A) Y7203 and Y7204 PTI Polling Cables, (B) Y2036 3-Module PTI Polling Cable, (C) Y2026 Cable/Adapter, (D) Y2022 Calibration Divider, (E) Y2024 3-Module Power Cord, (F) P20-Series Thermocouple Probes, (G) Y2037 and Y2039 RTD Probes, (H) Y2030 and Y2031 Plug-In Modules.

**Y2036 PTI Polling Cable**

Connects up to three PTI-family measurement instruments to 2020A or 2030A Printer

**Y2037 Platinum RTD Probe**

**Resistance:**  $100\Omega \pm 0.1\Omega$  at  $0^\circ\text{C}$

**Temperature Range:**  $-80^\circ\text{C}$  to  $+480^\circ\text{C}$

**Curve Conformity:**  $\pm 0.1\%$  of temperature using IPTS 68 with ALPHA = 0.0038994 and DELTA = 1.494

**Stability:** Periodic usage (20% of time)  $\pm 0.03^\circ\text{C}$  if used from  $0^\circ\text{C}$  to  $200^\circ\text{C}$  and  $\pm 0.22^\circ\text{C}$  if used from  $-80^\circ\text{C}$  to  $+480^\circ\text{C}$

**Hysteresis:** Less than  $\pm 0.08^\circ\text{C}$  when using  $0^\circ\text{C}$  and  $200^\circ\text{C}$  as end points

**Immersion Effects:**  $\pm 0.005^\circ\text{C}$  when going from 4 inches to 10 inches in an ice bath

**Transition End Temperature:**  $150^\circ\text{C}$  maximum

**Physical:** 316 SS Sheath, 0.25 in diameter x 12 in L; four 6 ft leads #22 AWG stripped and tinned

**Handling:** Contains strain-free platinum coil. Must be handled with care

**Y2039 Platinum RTD Probe**

**Probe Resistance:**  $100\Omega \pm 0.1\Omega$  at  $0^\circ\text{C}$

**Temperature Range:**  $-183^\circ\text{C}$  to  $+480^\circ\text{C}$

**Performance Standard:**  $R_{100}/R_0 = 1.3922$ , nominal. Conforms to IPTS 68 within 0.03% of temperature from  $-50^\circ\text{C}$  to  $420^\circ\text{C}$  using ALPHA = 0.0039221 and DELTA = 1.493

**Resistance Stability:** 12 m $\Omega$ /year when exposed at  $200^\circ\text{C}$  or 20 m $\Omega$  in 250 hours when exposed at  $480^\circ\text{C}$  measured with probe at  $0^\circ\text{C}$ . 4 m $\Omega$  =  $0.01^\circ\text{C} + 0.004\%$  of temperature

**Hysteresis:** Less than  $0.01^\circ\text{C}$  at  $200^\circ\text{C}$  when using  $0^\circ\text{C}$  and  $420^\circ\text{C}$  as end points

**Immersion Effects:** The readings shall not vary more than  $0.005^\circ\text{C}$  when probe is varied from 4 to 10 inches in an ice bath

**Transition End Temperature:**  $150^\circ\text{C}$  maximum

**Time Constant:** 8 seconds maximum when tested in flowing water at 3 feet per second

**Sheath Material:** INCONEL

**Size:** Diameter 0.64 cm (0.25 in), length 30.5 cm (12 in)

**Leads:** 4 wires, 6 ft, #22 AWG, ends stripped and tinned

**Calibration:** Each probe is calibrated at  $0^\circ\text{C}$ ,  $200^\circ\text{C}$  and  $420^\circ\text{C}$ . The IPTS 68 constants R<sub>0</sub>, ALPHA, DELTA and A<sub>4</sub> are provided

**Handling:** Contains strain-free platinum coil. Must be handled with care

**PTI Case Dimensions**

Style	Height	Width	Depth
A	5.7 cm (2.25 in)	20.5 cm (8.05 in)	32.6 cm (12.85 in)
B	8.2 cm (3.23 in)		
C	10.5 cm (4.13 in)		
D	12.8 cm (5.03 in)		

**General Specifications for 2180A/2189A/2190A**

**Display:**  $^\circ\text{F}$  or  $^\circ\text{C}$ , switch-selectable; 7 segment 1.1 cm LEDs

**Measurement Method:** Dual-slope integration, 100 ms integration time, 3.33 readings/second

**Linearization Technique:** Segmented 4th order curve fit

**Temperature Coefficient:**  $\pm 15$  ppm/ $^\circ\text{C}$  from  $25^\circ\text{C}$

**Stability:** 175 ppm/90 days, 200 ppm/year

**Common Mode Voltage:** 350V dc, 250V rms ac, max

**Common Mode Noise Rejection:**  $\geq 160$  dB at 50, 60 and 400 Hz  $\pm 0.1\%$  100 $\Omega$  unbalance

**Normal Mode Noise Rejection:**  $\geq 90$  dB at 50, 60 and 400 Hz  $\pm 0.1\%$

**Drift:** None, automatic zero correction

**Input Impedance:** 1000 M $\Omega$  at dc

**Accessory Connector:** 25-pin rear panel receptacle interfaces thermometer to Y2000, Y2001, Y2002, Y2003, and 2300A

**Shock and Vibration:** Meets MIL-T-28800C, class 3 specifications

**Ambient Temperature:**  $0^\circ\text{C}$  to  $50^\circ\text{C}$  operating,  $-40^\circ\text{C}$  to  $75^\circ\text{C}$  non-operating

**Relative Humidity:**  $\leq 80\%$  from  $0^\circ\text{C}$  to  $50^\circ\text{C}$  non-condensing

**Power:** 12V dc or 100, 120, 220, 240V ac  $\pm 10\%$ , selectable, 50 to 400 Hz; 8W typical

**Size:** Style C PTI case

**Weight:** 2.1 kg (4.63 lb)

**Included:** Instruction manual, power cord. Probes are not included

**Warranty Period:** 1 year

\*Also applies to Y2000, Y2001, Y2002, and Y2003

**Models**

January 1985 prices

**RTD Thermometers**

2180A Type 2 Linearizations\* ..... \$1095

2189A System ..... 1795

\*Contact factory for 3-wire 10 $\Omega$  copper applications

**Thermocouple Thermometer**

2190A Type 1 — J, K, T, R, C ..... 1045

2190A Type 2 — J, K, E, R, S ..... 1045

2190A Type 3 — J(DIN), K, T(DIN), B, R ..... 1045

**Options\*\*\***

21X0A-002\* Output ..... 395

21X0A-006 Limits ..... 255

2XXXA-522\*\* Personality Card for 1120A ..... 390

Note: Above options are field-installable.

\* Required for IEEE-488 compatibility and/or with 2020A-004 or 2030A Printer. However, the option is not required when the thermometer is used with a 2300A Scanner, unless analog output is also needed.

\*\* Required with 1120A Translator for IEEE-488 compatibility. Y7203 or Y7204 Cable also required.

\*\*\* All options are customer installable



# DIGITAL THERMOMETERS

## 2180A/2189A/2190A

### Accessories (Also see page 230)

Y2000 Multipoint Selector for RTDs .....	610
Y2001 Multipoint Selector for Thermocouples .....	610
Y2002 Alarms Output Module .....	720
Y2003 Thermocouple Calibrator/Battery Pack .....	685
Y2009 Battery Pack, Rechargeable .....	430
Y2022 Thermometer Calibration Divider .....	125
Y2026B RS-232-C Cable Adapter .....	170
Y2030 Thermocouple Input Module .....	90
Y2031 RTD Input Module .....	90
Y2023 Size C PTI Case w/drawer .....	125
Y2034 Interconnect .....	230
Y2024 3-Module Power Cord .....	20
Y2036 PTI Polling Cable .....	80
Y2037 RTD Probe 100 $\Omega$ 390 PT .....	260
Y2039 RTD Probe 100 $\Omega$ 392 PT .....	700
Y7203 2-ft 36-pin PTI Cable .....	45
Y7204 5-ft 36-pin PTI Cable .....	60

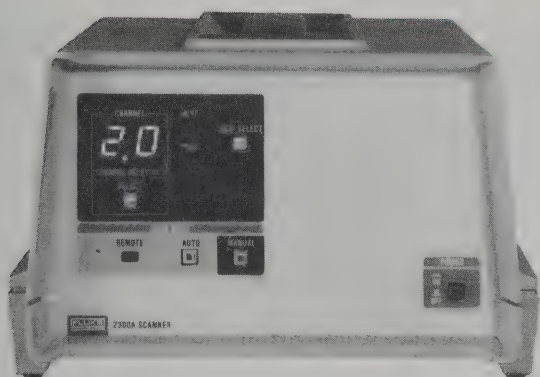
Also see page 181, 2030A Printer/Plotter; page 175, 2300A Scanner and page 218, IEEE-488 Translator.

### After-Warranty Service (See page 227)

SC1-2180A, per 90-day interval .....	112
SC1-2189A, per 90-day interval .....	132
SC1-2190A, per 90-day interval .....	100

# TEMPERATURE SCANNER

2300A



2300A

## 2300A Temperature Scanner

- Can be used with either thermocouples or RTDs
- Capable of scanning 20 points, and expandable to 100 points with the 2301A Extender Chassis
- Scanning can be either manually or automatically with a set interval time
- Unused channels can be skipped either through a switch setting or programmed from the front panel
- Two interface options. One provides remote programming capabilities
- LED display specifies the channel being monitored
- Two different types of thermocouples or RTDs can be used per input card
- Designed to be integrated with a wide variety of instruments and accessories through an integral latching system
- Capable of running off of 12V dc or ac line power

The 2300A Temperature Scanner is designed to be used with either a Fluke 2180A or 2190A Digital Thermometer to sequentially scan and read the temperature of up to 20 RTDs or thermocouples. For even more capacity, a 2301A Scanner Extender can be added to scan an additional 30 sensors. Two 2301As may be stacked and latched together to scan up to 80 channels and a third may be added to scan up to 100.

Scanning may be done one channel at a time manually, with keystrokes at the front panel, or automatically. Readings also may be printed at pre-selected intervals using either a Fluke 2030A Printer or a 2020A Printer with the relevant options. All of these instruments are packaged in Fluke stack-and-latch cases that quickly and easily fit together to become an integrated, multichannel, temperature scanning and logging system. Using a 12V battery, a system may be operated in the field, away from any ac power source.

### Scanner Card Options (-002 & -003)

Both the -002 Thermocouple Scanner Card Option and the -003 RTD Scanner Card Option provide for 10 sensor inputs. The inputs are divided into two blocks of five, so two different thermocouple types (or two different RTD types) may be used with each card. A switch allows you to automatically skip any unused channels, or you may skip them from the front panel of the Scanner.

Up to two cards (20 channels) may be housed in a 2300A Scanner, and up to three cards (30 channels) in a 2301A Scanner Extender. At least one scanner card is required for the 2300A to operate. Thermocouples and RTDs may not both be scanned at the same time by one 2300A.

### Interface Card Options (-005 & -006)

Two interface options are available. One or the other is required and only one may be installed at a time. Either option will interface to either a 2180A or 2190A, and both provide RS-232-C output for communication to external printers or computers. Only Option -006 allows remote control of the Scanner, however, via either a bi-directional RS-232-C link or via the IEEE-488 bus (with the 1120A Translator). No interface option is required for a 2301A Scanner Extender.

The Y2026B RS-232-C Cable Adapter is available to connect the 36-pin connector on the back of the Scanner to a cable with a standard 25-pin connector. Or you can wire your own cable to the connector provided.

## Specifications

**Channel Capacity:** 10 or 20 channels in a 2300A; 10, 20, or 30 channels in each 2301A Extender Chassis; 100 channels per system, maximum. Each system to scan only RTDs (2180A) or only thermocouples (2190A)

**Front Panel Programming:** Automatic or Manual Scanning, Channel Skips, Channel Delay Time, Fast Forward, Fast Reverse

**Display:** Two digits, 00 through 99; either channel number or channel delay time

**Channel Delay Time:** Time interval between scanner relay contact closure and scanner trigger signal that initiates measurement instrument reading. Programmable from 0.0 to 8.0 seconds, 2 seconds or greater required for rated accuracy

**Printer Control of Scan Interval:** Either the 2020A Printer (with Option -004 and -006) or the 2030A Printer can be programmed to control the time between each scan cycle when connected to the 2300A

**Scan Speed:** Dependent on measurement instrument and application  
**Required Options:** One Interface Option (-005 or -006) and at least one Scanner Card Option (-002 or -003). Also, one to three scanner card options per 2301A Extender Chassis

**IEEE-488 System:** Requires 1120A Translator with Option 2XXXA-522 installed and Y7203 PTI cable

**RS-232-C Compatibility:** Y2026B Cable/Adapter recommended

## Option Specifications

### Thermocouple Scanner Card Option (-002)

**Input Channels:** 10

**Input Connections:** Two wires per channel on screw terminal isothermal block

**Thermal Offset Error:** 1 microvolt, max

**Channel Switches:** 2-pole reed relays

**Max Input Voltage:** 170V dc or peak ac

**Max Common Mode Voltage:** 350V dc or peak ac between any two channels or between the chassis and a channel

**Thermocouple Types:** See 2190A Thermometer Specifications

**Switch-selectable Types:** Two; five channels per thermocouple type  
**Reference Junction Compensation:** Temperature-sense transistor on scan card isothermal block is used to send isothermal block temperature to 2190A for automatic ice point compensation

### RTD Scanner Card Option (-003)

**Input Channels:** 10

**Input Connections:** 4-wire screw terminal

**Thermal Offset Error:** 10 microvolts max

**Channel Switches:** 3-pole reed relays

**Max Input Voltage:** 30V dc or peak ac

**RTD Types:** See 2180A Specifications

**RTD Types Selectable:** Two; five channels per RTD type

### Interface Option (-005)

Interface Option -005 includes an attached accessory cable with a 25-pin male connector that plugs into the back of a 2180A or 2190A Digital Thermometer. The Option also provides a rear panel 36-pin connector for outputs to printers and computers



# TEMPERATURE SCANNER

## 2300A

### 36-Pin Connector

The Portable Test Instrument (PTI) connector is used to transfer information from a 2300A Scanner and 2180A or 2190A Thermometer to a printer, RS-232-C device, or IEEE-488 bus via the Fluke 1120A Translator. The output information is: Channel number, temperature value, temperature scale ( $^{\circ}\text{C}$  or  $^{\circ}\text{F}$ ), open circuit symbol, overrange symbol, limit-exceeded symbol, (if 2180A or 2190A has Option -006), carriage return (CR), and line feed (LF). A Y7203 Accessory Cable is required for connecting a printer or 1120A Translator. A Y2026B Cable/Adapter is recommended for transmitting RS-232-C signals.

**RS-232-C Signals:** Transmitted Data, Request To Send, Clear To Send, Data Set Ready, Data Terminal Ready, Ground. Source and controlled sink of 20 mA for TTY current loop operation. Baud rates are 110, 150, 300, 600, 1200, 2400, 4800, or 9600, switch-selectable.

**IEEE-488 Signals:** All IEEE Std 488-1978 signals when used with 1120A Translator with Option 2XXXA-522 installed. Interface functions SH1, AH1, T6, L4, SR1 can be implemented.

### Interface & Remote Control Option (-006)

Option -006 provides all the features of Option -005 plus the capability to be remotely programmed via the 1120A IEEE-488 Translator or RS-232-C terminal.

**I/O Connections:** Same as Option -005 except 36-pin connector also used for remote control inputs.

**Signals:** Same as Option -005 plus Received Data, Received Line Signal Detector, and Scanner Busy (for RS-232-C). TTY current loop is available as an output but cannot be used to send programming commands.

**Remote Programming:** The 2300A accepts commands for programming channel delay time, channel skips, monitor channel, first and last channel single scans, and first and last channel continuous scanning. Programming is activated by sending command character codes on data lines of IEEE bus via the 1120A Translator or on the Received Data line via an RS-232-C device.

### Command Characters & Meanings

R	Place Scanner in Remote Control
L	Place Scanner in Local Control
D mm	Set channel delay time to m.m seconds
S mm-nn	Skip channels mm to nn
U mm-nn	Unskip channels mm to nn
M mm	Monitor channel mm
A mm-nn	Continuously scan from channel mm to nn
X mm-nn	Make a single scan from channel mm to nn
RP	Print Scan Mode
MP	Print current channel
AP	Print first and last channels
XP	Print first and last channels
DP	Print channel delay

### General Specifications

**Ambient Temperature:**  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ , operating;  $-20^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ , non-operating.

**Relative Humidity:**  $\leq 75\%$  to  $50^{\circ}\text{C}$ , operating;  $\leq 95\%$  to  $70^{\circ}\text{C}$ , non-operating.

**Safety Standards:** IEC 348 Protection Class I, solely as it relates to insulation or grounding properties.

### Power

**2300A:** 100 to 130V ac or 200 to 260V ac, switch-selectable, 50 to 60 Hz, or 12V dc. 8 Watts.

**2301A:** Supplied by the 2300A Scanner mainframe.

**Size:** Style D PTI case, 13.1 cm H x 20.5 cm W x 32.7 cm L (5.15 in x 8.05 in x 12.85 in) both 2300A and 2301A.

### Weight

**2300A:** Approximately 3.6 kg (8 lb) depending on the options.

**2301A:** Approximately 2.7 kg (6 lb) depending on the scanner cards installed.

### Included

**2300A:** Instruction manual, power cord, attached cable for 2180A or 2190A.

**2301A:** Instruction manual, attached cable for 2300A or another 2301A.

### Models

January 1985 prices

2300A Scanner	\$675
2301A Extender Chassis	425

Interfacing a 2300A Scanner/Thermometer combination to the IEEE Bus requires a Y7203 or Y7204 Cable, the 1120A Translator and the 2XXXA-522 Personality Card. The 21X0A-002 thermometer option is not required.

### Options

2300A-002 Thermocouple Scanner Card	435
2300A-003 RTD Scanner Card	435
2300A-005* Interface and Output	325
2300A-006* Interface, Output and Remote Control	1097

\* Includes attached ribbon cable for 2180A or 2190A. For factory or Service Center installation only.

### Accessories (Also see page 230)

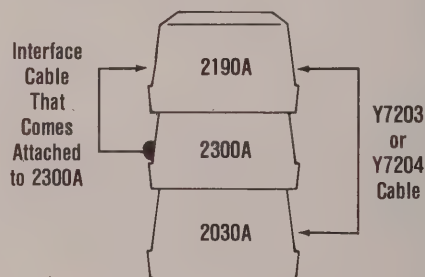
1120A IEEE-488 Translator	520
2XXXA-522* Personality Card for 1120A	390
Y7203 36-Pin PTI Cable, 2 ft	45
Y7204 36-Pin PTI Cable, 5 ft	60
Y2026B** RS-232-C Cable/Adapter	170

\* Required with 1120A Translator for IEEE-488 compatibility. Y7203 or Y7204 Cable also required.

\*\* Includes cable for connection to 2300A. Has both male and female 25-pin RS-232-C connectors and switches for handshake flexibility.

### After-Warranty Service (See page 227)

SC1-2300A, per 90-day interval	100
SC1-2301A, per 90-day interval	52



Typical Cable Connections

# TEMPERATURE LOGGING SYSTEMS

## 2382A/2383A/2392A/2393A Temperature Logging Systems



2393A Temperature Logging System

### 2382A/2383A/2392A/2393A

- Completely configured and tested temperature logging systems
- Capable of running off of 12V dc or ac line power
- Capable of scanning 20 points, and expandable to 100 points with the 2301A Extender Chassis
- Scan either manually or automatically with a set interval time
- Your choice of either the 2020A or the 2030A Printer and either RTD or thermocouple capability
- Six different RTD types are switch selectable. Four platinum, one nickel, one copper, (2382A and 2383A only)
- Ten different thermocouple linearizations are supported including two DIN standards, (2392A and 2393A only)

Four portable, factory-integrated and tested temperature logging systems are available. They offer a choice of thermocouple or RTD measurements and a choice of two printers — the Fluke 2020A or 2030A. Temperature information from up to 10 sources may be logged using any of the four systems, or up to 20 by ordering one additional scanner option (-003 for RTDs or -002 for thermocouples). And each system may be expanded to monitor up to 100 points. Although the component parts may be ordered separately and assembled by the user, choosing the right combination of instruments, options, cables, etc., for your application is simplified by purchasing one of the four systems. There is even a modest price advantage in purchasing a factory-tested system. Each offers the most accurate temperature logging capability that Fluke manufactures.

The following chart shows the component parts of the four systems.

### System Components

Items Included	RTDs		Thermocouples		See Page
	2382A	2383A	2392A	2393A	
2180A Thermometer	1	1	—	—	168
2190A Thermometer	—	—	1	1	168
2300A Scanner	1	1	1	1	175
Option -005	1	1	1	1	175
Option -003*	1	1	—	—	175
Option -002*	—	—	1	1	175
2030A Printer	—	1	—	1	181
2020A Printer	1	—	1	—	178
Option -004	1	—	1	—	179
Y7203 Cable	1	1	1	1	173
Y2024 Power Cord	1	1	1	1	173

\* Ten channels per option. One additional option may be installed in the 2300A. Up to 3 additional options may be plugged into each additional 2301 Scanner Extender. Maximum number of channels is 100.

### Specifications

Please refer to the pages listed above for the specifications and performance characteristics of the instruments and options comprising each system

### Models

January 1985 prices

2382A RTD System with 2020A Printer .....	\$3795
2383A RTD System with 2030A Printer .....	3895
2392A T/C System with 2020A Printer .....	3755
2393A T/C System with 2030A Printer .....	3895

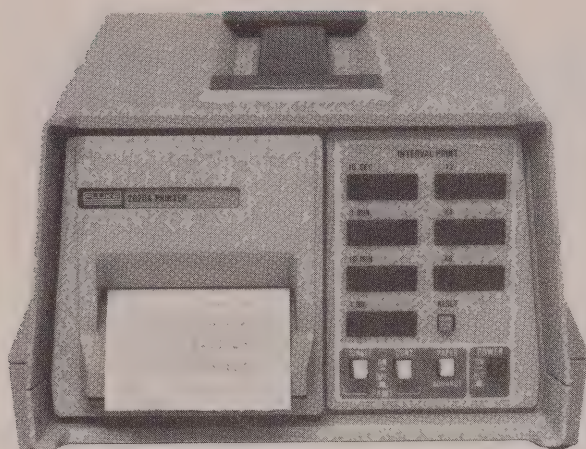
### After-Warranty Service (See page 227)

SC1-2382A, per 90-day interval .....	400
SC1-2383A, per 90-day interval .....	400
SC1-2392A, per 90-day interval .....	380
SC1-2393A, per 90-day interval .....	380



# UNIVERSAL & COMPUTING PRINTERS

2020A



2020A With Option -006

## 2020A Universal Printer

- 20-column thermal printer for recording data from a variety of instruments
- Five different interface options are available: Parallel ASCII, RS-232-C, IEEE-488, PTI Polling or Parallel BCD
- Designed to be integrated with a wide variety of Fluke instruments and accessories through an integral latching system
- Time interval print capability with the -006 option
- Capable of running off of 12V dc or ac line power
- Single or continuous print cycles can be triggered either from the front panel or using the remote trigger connector on the rear of the instrument
- Graphic plotting available when using the -001 or the -003 interface

Both the 2020A and 2030A Printers have 20-column thermal print heads for recording measurement data from a variety of Fluke instruments. Especially recommended are those instruments packaged in Fluke's Portable Test Instrument (PTI) cases. They will stack and latch to a 2020A or 2030A Printer and to one another. Connecting cables attach to the rear panels.

Because the 2300A Scanner is designed to let you measure the temperature of numerous points with just one Fluke 2180A or 2190A Thermometer, the 2020A and 2030A Printers are particularly recommended for temperature scanning and logging. Thermometer, scanner, and printer are stacked and latched together and used as an integrated temperature measuring system. The following chart gives a quick comparison of the two printers.

## Comparison of 2020A and 2030A Printers

Features	2020A	2030A
<b>Prints</b>		
Measured data	Yes	Yes
Computed data	No	Yes
Data source identification	Yes	Yes
Real time	No	Yes
Elapsed time	Opt -004	Yes
Time interval	Opt -006	Yes
Engineering units	No	Yes
Header	No	Yes
Strip chart graph	*	Yes
<b>Print Cycle</b>		
Front panel trigger	Yes	Yes
Remote trigger	Yes	Yes
Front panel continuous	Yes	Yes
Remote continuous	Yes	Yes
Pre-selected intervals	Opt -006	Yes
When limit crossed	No	Yes
Intervals and crossings	No	Yes
<b>Computed Data</b>		
mx+b scaling	No	Yes
± difference (delta)	No	Yes
±% (% delta)	No	Yes
<b>Interfaces</b>		
Fluke PTI	Opt -004	Yes
RS-232-C	Opt -002	No
IEEE-488	Opt -003	No
Parallel ASCII	Opt -001	No
Parallel BCD	Opt -005	No

\* Using Option -001 or -003 and 1722A Instrument Controller or similar computer.

## 2020A Universal Printer

The Fluke 2020A is a 20-column thermal printer — the first printer with five interchangeable data interface options. Whether you need IEEE-488, RS-232-C, BCD, parallel ASCII, or Fluke's own Portable Test Instrument (PTI) polling interface, the 2020A has the option to match. The 2020A operates from either the ac power line or a nominal 12-volt dc source.

## Graphic Printing

The 2020A with a parallel ASCII or IEEE-488 interface is capable of printing a dotted graph of incoming data. The data source must send the correct 8-bit binary code for trace-on, 0 through 99 for the dot location, line feed, and finally trace-off. Use this feature to plot trends and trace profiles in addition to normal print out.

## PTI Polling

The 2020A's PTI polling interface contains a microcomputer with addressing intelligence designed to generate the assigned addresses of several instruments in the PTI family. Select a print mode and the 2020A automatically begins polling by sequentially sending addresses one through nine until a measurement instrument recognizes its address. The 2020A then prints both the address and the instrument's current reading. A typical polling system might include the 2020A with a 2190A Thermometer and a 8920A Voltmeter.

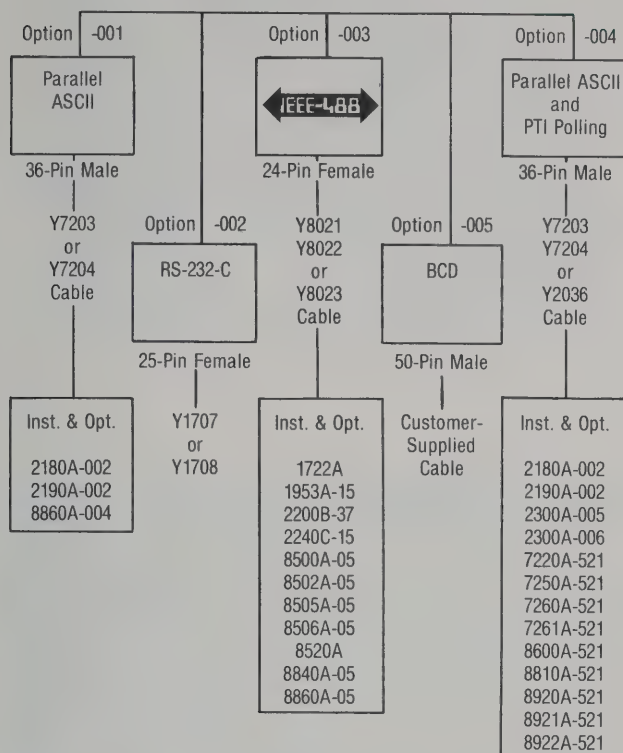
## Time Interval Printing

Fluke offers the 2020A with time interval printing (Option -006). It allows printing at preselected time intervals from ten seconds up to eight hours. When you use the time interval print option and a PTI polling interface, the 2020A will automatically label the printer tape with elapsed time each time it prints a set of readings.

# UNIVERSAL & COMPUTING PRINTERS

2020A

Your choice of five field-installable interface circuit cards.



## Option Specifications

### Parallel ASCII Interface (-001)

**Input Connector:** 36-pin AMP CHAMP, male

**Signals:** Data, 8 lines; Data Valid; Data Acknowledge

**Signal Levels:** Data, positive True,  $\geq +3.5V$ . Data Valid, Data Acknowledge lines — negative True,  $\leq +1.5V$

**Character Set:** 64 upper case ASCII plus °, f, k, m, n, p, Ω, s, μ, z

**Graphic Printing:** Dotted trace activated by receipt of the following binary-coded decimal numbers on incoming data lines: in-trace — 16, dot location — 0 through 99, line feed — 254, out-trace — 255.

### RS-232-C Interface (-002)

**Input Connector:** Standard 25-pin, female

**Signals:** Transmitted Data, Clear to Send, Data Set Ready, Signal Ground, Received Line Signal Detector

**Baud Rates:** Switch-selectable for 110, 150, 300, 600, or 1200

**Character Set:** 64 upper case ASCII plus °, f, k, m, n, p, Ω, s, μ, z

**Buffer Storage:** 32 characters

### IEEE-488 Interface (-003)

**Input Connector:** Standard 24-pin, female

**Signals:** Per IEEE Std 488-1978

**Modes:** Listen only or Addressable Listen, Switch-selectable

**Repertoire:** AH1, L1

**Character Set:** 64 upper case ASCII plus °, f, k, m, n, p, Ω, μ, z

**Graphic Printing:** Dotted trace activated by receipt of the following binary-coded decimal numbers on incoming data lines: in-trace — 16, dot location — 0 through 99, line feed — 254, out-trace — 255.

**Buffer Storage:** 1 line of data

### PTI Polling Interface (-004)

**Multi-Instrument Scanning:** Up to nine Fluke measurement instruments with each having an internal preset address as follows: Adr 1 — 2180A, 2190A, 2300A; Adr 2 — 7250A, 7260A, 7261A; Adr 3 — 7220A; Adr 4 — 8920A, 8921A, 8922A; Adr 5 — 8600A, 8810A; Adr 6, 7, 8, 9 — 2180A, 2190A, 2300A

**Input Connector:** 36-pin AMP CHAMP, male

**Signals:** Data, 8 lines, Address, 4 lines; Address Valid; Data Valid; Data Acknowledge; Scan in Progress

**Character Set:** 64 upper case ASCII plus °, f, k, m, n, p, Ω, s, μ, z

**Buffer Storage:** 1 line of data

### Parallel BCD Interface (-005)

**Input Connector:** 50-pin AMP CHAMP, male. Mating female connector included

**Signals:** Data, 44 lines; Busy; Trigger Out, 2 lines, positive or negative true

**Signal Level:**  $\geq 3.5V$  positive True, TTL, DTL, CMOS B series

**Decimal Point:** Either fixed location (switch-selectable) or remotely BCD programmed, determined by jumper position

**Column Usage:** Either 7 columns of data and 4 columns of annotation with switch-selectable decimal point or 7 columns of data and 3 columns of annotation with programmable decimal point position, jumper selectable

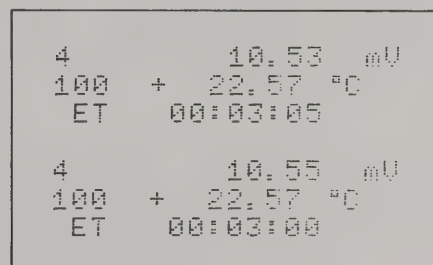
**Buffer Storage:** 1 line of data

### Time Interval Print (-006)

**Print Intervals:** Choice of 10, 20, 40, or 80 seconds, 1, 2, 4, 8, 10, 20, 40, or 80 minutes, or 1, 2, 4, or 8 hours

**Time Annotation:** Elapsed time printed with each reading when Option -004 installed

**Clock:** Internal, crystal-controlled



Sample section of printed tape showing two readings 5 seconds apart. Reading from bottom to top: Elapsed time (ET) is 00 hours, 03 minutes, and 00 seconds. Address 1 Channel 00 is for the thermometer and address 4 is for the voltmeter.

## Specifications

**Type:** Thermal, 20-column

**Characters:** 5 x 7 dot matrix

**Print Rate:** 3 lines per second maximum

**Spacing:** 6 lines per inch (2.4 per cm)

**Paper:** 2.5 in (6.3 cm) wide, 240-ft roll (74 m)

**Advance:** Stepping motor, belt drive

**Remote Operation:** Rear input, by external contact closure, TTL/DTL compatible

**Standards:** IEC 348, Protection Class 1

**Temperature:** 0°C to 50°C, operating: -20°C to +70°C, non-operating

**Relative Humidity:**  $\leq 95\%$  to 25°C;  $\leq 75\%$  to 40°C;  $\leq 45\%$  to 50°C

**Power:** 11 to 15V dc, 90 to 132V ac, or 180 to 250V ac, switch-selectable, 47 to 440 Hz, 40W maximum

**Size:** Style D PTI Case — 13.1 cm H x 20.5 cm W x 32.7 cm L (5.15 in x 8.05 in x 12.85 in)

**Weight:** Approximately 9 lb with paper

**Included:** Instruction manual, power cord, one roll of paper



# UNIVERSAL & COMPUTING PRINTERS

## 2020A

### Model

January 1985 prices

2020A Printer ..... \$875

*Each printer requires one interface option and can only use one at a time.*

### Options

202XA-001\* Parallel ASCII Interface ..... 285  
 202XA-002 RS-232-C Interface ..... 345  
 202XA-003 Interface for IEEE-488 ..... 345  
 202XA-004\* PTI Polling Interface ..... 345  
 202XA-005 Parallel BCD Interface ..... 465  
 202XA-006 Time Interval Print ..... 225

*All options field-installable. Cables not included.*

*\*Accepts Y7203 or Y7204.*

### Accessories (Also see page 230)

Y2036\* PTI Polling Cable ..... \$80  
 Y7203 2-ft Cable, 36-Pin, PTI ..... 45  
 Y7204 5-ft Cable, 36-Pin, PTI ..... 60  
 Y8021 1m Cable for IEEE-488 bus ..... 85  
 Y8022 2m Cable for IEEE-488 bus ..... 95  
 Y8023 4m Cable for IEEE-488 bus ..... 105  
 Y2035 Thermal Paper, box of 10 rolls ..... 65

*\* Used when 2 or 3 PTI instruments are to be simultaneously connected to 2020A via Option -004. Use two cables for 4 or 5 instruments.*

### After-Warranty Service (See page 227)

SC1-2020A, per 90-day interval ..... 96



2030A

### 2030A Computing Printer

- 20-column thermal printer for recording data from a variety of instruments
- Multi-instrument scanning (up to 9)
- Time annotation — real, elapsed, interval
- Engineering units annotation — up to 4 alphanumeric characters
- Seven print modes
- Runs off 12V dc or ac line power
- Trace mode allows plotting of data
- Designed to be integrated with a wide variety of instruments and accessories through an integral latching system
- Math mode allows you to program delta, %delta, and  $mx+b$  scaling
- Checks for both high and low alarms

The 2030A is a 20-column thermal printer with computing power. It combines standard printing performance with a multitude of other special features. It is capable of mathematically scaling data and automatically documenting the printed results. It can translate numeric data into a visual trace, and it can apply limits and activate alarms. The 2030A prints data in any one of seven modes—from a single reading to programmed printing at periodic intervals.

### Seven Print Modes

**Trace:** Data graphically plotted between programmable limits

**Interval Trace:** Graphic trace of data plotted at programmed time intervals

**Interval:** Prints at programmed intervals

**Interval Limit:** Prints at programmed intervals and monitors for alarms when not printing

**Single:** Prints one reading when pushbutton is pushed

**Continuous:** Continuously prints up to three readings per second

**Remote:** Prints continuously when activated (via rear panel)

### Time Interval Printing

Inside the 2030A is a precision crystal measuring time and allowing you to control when data is scanned and/or printed. A 99-hour clock is set from the front-panel keyboard; elapsed time starts automatically when the power is turned on. The 2030A automatically annotates the tape with the selected time whenever it prints data.

### Multi-instrument Scanning

The 2030A's microcomputer contains addressing intelligence designed to generate the assigned addresses of PTI family instruments. Select a print mode and the 2030A automatically begins scanning by sequentially sending addresses one through nine until a measurement instrument recognizes its address. The 2030A then prints both the address and the instrument's current reading, and polls the next instrument having a higher address. A typical printing system might include the 2030A with a 2190A Thermometer and an 8920A Voltmeter. One or more Y2036 PTI Polling Cables are needed for connecting more than one instrument in parallel to the 2030A.

### Math Power

Simply enter two 6-digit constants from the front panel and the printer can calculate the difference (delta) or percent difference (% delta) between a preselected reference value and the input data. You can also program the 2030A to scale the incoming data. You could, for example, correlate voltage and pressure, converting a range of 4-20 mA into 0-100 PSI.

### Graphic Printing

Select the range of data you want to analyze and the 2030A will plot a dotted graph over a 2 inch full scale band of the tape. Simply program the right and left limits of the graph area as if they were 0% and 100%. Whether the measurement range is "0 to 1000" or "500 to 510," the 2030A automatically expands or contracts the range to fit within the 2 inch scale, and dot by dot plots a graph of the data you're recording.

### Alarms

To control and monitor processes, the 2030A gives you the ability to continuously compare the reading of a measuring instrument against two programmable limits with six-digit resolution. If the reading exceeds either the high or the low limit, the 2030A prints the reading, the time, and activates an alarm output.

When the 2030A is in its trace mode, the edges of the graph also act as alarm set points.

### Engineering Units

The 2030A can be programmed to annotate data with the engineering units you choose. It overrides the basic measuring instrument's units with four alphanumeric symbols. Use this feature for math scaling and offset to put converted data in the proper units, or to indicate % when printing percent or difference (% delta).

### Mode and Function Identification

Each print mode and special function has a distinct label. At the beginning of each print cycle, the 2030A automatically prints the appropriate labels so you know just what operations are to be performed. In the "interval limit" mode, for example, the 2030A prints Hi and Lo followed by the values assigned to each limit.

All labels include real time or elapsed time when in use, instrument address, and a 6-digit header (HD) to indicate the month, day, and year or other meaningful documentation. The diversity of symbols and special diagnostic messages add up to data that's easy to interpret today or weeks from now.

### Specifications

**Printer Type:** Thermal, 20-column

**Characters:** 5 x 7 dot matrix

**Character Set:** 64 upper case ASCII plus °, f, k, m, n, p, Ω, s, μ, z

**Print Rate:** One line for each linefeed command, 3 lines/second max

**Spacing:** 6 lines per inch (approximately 2.4 lines per cm)

**Paper:** 2.5 inches wide, 240-foot roll.

**Paper Advance:** Stepping motor, belt drive



# UNIVERSAL & COMPUTING PRINTERS

## 2030A

**Buffer Storage:** 1 line of data

**Decimal Point:** Automatically printed in correct location

**Print Head Test:** Test pattern printed in all columns if paper advance depressed within 1 second of power turn on

**Print Modes:** SINGLE, CONTINUOUS, INTERVAL, INTERVAL LIMIT, TRACE, INTERVAL TRACE, and REMOTE (operated by contact closure, TTL- or DTL-compatible)

**Programmable Units:** Up to four characters programmed from front panel. Code set is 64 upper case ASCII characters plus °, f, k, m, p, Ω, s, μ and z. Overrides incoming units

**Programmable Parameters:** Time, Interval, Header, A constant, B constant, Hi Lim, Lo Lim, Units, Spec Adr. All are programmed from front panel

**Clock:** Internal crystal. Will measure time intervals and either elapsed time or real-time. Resolution is one second; range is 99 hours, 59 minutes, and 59 seconds. Four modes: Elapsed time only, real-time only, elapsed time and time interval, or real-time and time interval. Real-time runs continuously and elapsed time is reset at the start of each print cycle.

**Alarm:** Two 6-digit setpoints, assignable, corresponding to six least significant digits of any one measurement instrument. Output is open collector, 28V max. Sinks 30 mA max.

**Graphic Printing:** Trace is programmed by proper selection of A and B constants. Operates on one instrument. Graph scale is 2-1/8 inches (100 dots) wide. Ten percent scale markers printed. Accuracy ±2% of graph scale.

**Math:** Programmable to do scaling, delta, and % delta computations by proper selection of A and B constants. Operates on one instrument. Six-digit printout, maximum. Accuracy dependent on scale selected.

**Compatible Instruments & Options:** 2180A-002, 2190A-002, 2300A-005, 2300A-006, 7220A-521, 7250A-521, 7260A-521, 7261A-521, 8600A-521, 8810A-521, 8920A-521, 8921A-521, 8922A-521

**PTI Polling:** Prints sequential readings from up to nine Fluke measurement instruments with each having an internal preset address as follows: Adr 1 — 2180A, 2190A, 2300A; Adr 2 — 7250A, 7260A, 7261A; Adr 3 — 7220A; Adr 4 — 8920A, 8921A, 8922A; Adr 5 — 8600A, 8810A; Adr 6 — 2180A, 2190A, 2300A; Adr 7, 8, and 9 — Indirect Addresses. When a thermometer accessory is attached to the 2180A or 2190A via the thermometer accessory connector, the combination of thermometer and accessory acts as one instrument when polled.

**Thermometer Interface:** Plug compatible with 2180A/2190A with 21X0A-002 output option installed

**Scanner Interface:** Plug compatible with 2300A Scanner. The 2180A or 2190A Thermometer attached to the 2300A Scanner does not require a 21X0A-002 output option.

**Interface:** Through 36-pin AMP CHAMP, male connector. Signals: Data, 8 lines; Address, 4 lines; Address Valid; Data Valid; Data Acknowledge; Scan in Progress.

**Standards:** IEC 348 Protective, Class 1

**Temperature:** 0°C to +50°C, operating; -20°C to +70°C, non-operating

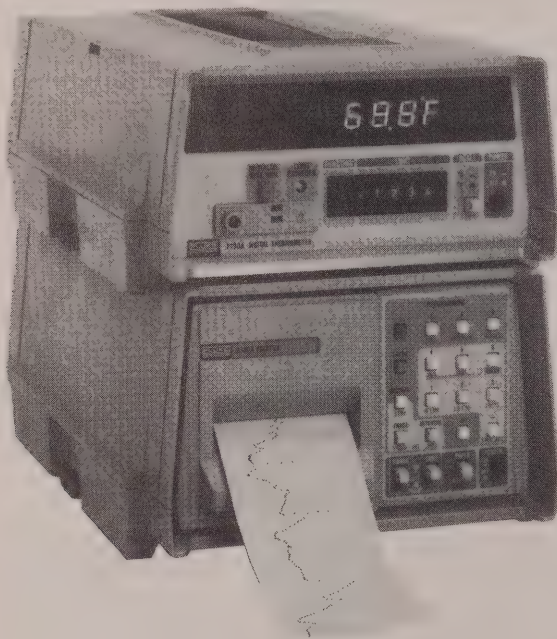
**Relative Humidity:** ≤95%, 0°C to 25°C; ≤75% to 40°C; ≤45% to 50°C

**Power:** 11 to 15V dc, 90 to 132V ac, or 180 to 250V ac, 47 to 440 Hz, 40VA maximum

**Size:** PTI style D case — 13.1 cm H x 20.5 cm W x 32.7 cm L (5.15 in x 8.05 in x 12.85 in)

**Weight:** approximately 9 lb with paper

**Included:** Manual, power cord, one roll of paper



2190A/2030A Graphics Capabilities

### Model

January 1985 prices

2030A Printer ..... \$1415

Interconnecting cables not included. Order Y7203 or Y7204

### Accessories (Also see page 230)

Y2035 Thermal Paper, box of 10 rolls ..... 65

Y2036\* PTI Polling Cable ..... 80

Y7203 2 ft Cable, 36 pin PTI ..... 45

Y7204 5 ft Cable, 36 pin PTI ..... 60

\* Required when 2 or 3 measurement instruments are simultaneously connected to the 2030A. Use two cables for 4 or 5 instruments.

### After-Warranty Service (See page 227)

SC1-2030A, per 90-day interval ..... 96

## Introduction

Accurate and timely data is of critical importance both for monitoring industrial processes and collecting data in laboratory environments. To make informed decisions, relevant information should be collected and displayed at a central location, and the information presented should be clearly annotated and documented. Equally important, the instruments used to collect the data should be adaptable for a wide variety of tasks, and should be easy to configure and program. The solution to these diverse and difficult requirements is the modern data logger.

Fluke pioneered the modern data logger when it introduced the 2240A and 2200A in 1975. By integrating microprocessors into data loggers, power and flexibility that previously required dedicated computers was available in one table-top sized package. Fluke rapidly became the market leader in data loggers. These loggers were so powerful and versatile, that their direct descendents, the 2240C and 2200B are still available today.

The 2280 SERIES Data Loggers (the 2280B and the 2285B) represent the leading edge of technology, offering unmatched power and flexibility. Adaptable to almost any data acquisition requirement, the 2280 SERIES Data Loggers accommodate a wide variety of input and outputs integrated into a system with unmatched accuracy, flexibility and power. The 2280 SERIES Data Loggers allow the user to perform virtually any mathematical calculations or logical comparisons on the input data, perform control operations and output the results to a wide variety of devices. The true power of the 2280 SERIES Data Loggers is that all these tasks can be performed without knowledge of computers or writing any software. The 2280 SERIES Data Loggers offer solutions for today's complex applications in an integrated package that is easy to configure, setup, and operate.

## Selection Guide

Characteristics	2280B	2285B	2240C	2200B
<b>Inputs</b>				
Thermocouples	11 Types	11 Types	15 Types	15 Types
Thermocouples	11/System	11/System	8/System	4/System
RTDs	All Types	All Types	4 Types	4 Types
Resistance	to 64 k $\Omega$	to 64 k $\Omega$	—	—
DC Voltage	To 64V	To 64V	To 40V	To 40V
DC Resolution	1 $\mu$ V	1 $\mu$ V	1 $\mu$ V	1 $\mu$ V
AC Voltage	To 250V	To 250V	To 120V	To 120V
Current	DC	DC	DC	DC
Strain Gage	1/4, 1/2, Full	1/4, 1/2, Full	—	—
Contact (status)	Yes	Yes	—	—
Digital	BCD, Binary	BCD, Binary	—	—
Frequency	To 400 kHz	To 1 kHz	—	—
Event Totalize	Yes	Yes	—	—
Remote A/D	Yes	Yes	—	—
<b>Outputs</b>				
Alarm (Digital)	Yes	Yes	Yes	Yes
User Defined Digital	Yes	Yes	—	—
Analog	Yes	—	—	—
PID Control	Yes	—	—	—
<b>Channels</b>				
Per Mainframe	100	100	60	60
Per System	1500	100	1000	100
Indep. Prgm.	1500	100	256	10
Indep. Scan Grps	10	10	2	1
Conditional Scans	Yes	Yes	—	—
<b>Built-In Printer</b>				
Characters/Line	40	40	16	16
Channels/Second	11	11	2.5	2.5
Read Direction	Top to Bottom	Top to Bottom	Bottom to Top	Bottom to Top
Eng. Units	6 Characters	6 Characters	4 Characters	4 Characters
Channel Labels	15 Characters	15 Characters	—	—
Group Labels	40 Characters	40 Characters	—	—
Alarm Messages	40 Characters	40 Characters	—	—
Ack. Alarms	Yes	Yes	—	—
Plots Graphs	Yes	Yes	—	—
<b>On-Line Math</b>				
Time or Gp. Avg.	Yes	Yes	—	—
mX+b Scaling	Any Channel(s)	Any Channel(s)	To 30. Opt.	—
User Defined Calculations	Yes	Yes	—	—
Limits	4+/Channel	4+/Channel	4/Channel	4/Channel
Limits/System	6000	400	60	40
Advanced Math	Optional	—	—	—
<b>General</b>				
Programming	Menu-prompted	Menu-prompted	Pushbuttons	Pushbuttons
Prog. Security	Key and Code	Key and Code	Key	—
Prog. Volatility	90 Days	90 Days	5 Years	5 Years
Power	ac or 12V dc	ac or 12V dc	ac	ac
DC100 Tape	Optional	—	—	—
RS-232 I/F	Yes	Yes	Yes	Yes
IEEE-488 I/F	Yes	Yes	Yes	Yes
Remote Prog.	Yes	Yes	Yes	—
Remote Operation	Yes	Yes	Yes	—
Self Tests	Yes	Yes	—	—
U.S. Prices From	\$8520	\$6520	\$7550	\$3995



# What's Important When Selecting A Data Logger

## What Type of Signals?

The number and type of signals to be measured will determine the "hardware configuration" of your data logging system. The typical data logger can accept between 60-100 channels in its "mainframe" and requires "expansion" or "extender" chassis to handle additional inputs. Future system expansion should be considered because it can be a major impact on total costs. Almost all data loggers will measure ac and dc voltages, and accept inputs directly from current loops and thermocouples, but RTDs, strain gages and load cells sometimes require additional conditioning. In most data loggers, the expansion chassis is strictly an extension of the signal measuring circuitry and is connected to the data logger through expensive multi-conductor cabling that limits the distance the expansion chassis can be located from the mainframe. Additionally, status input and status (relay) output functions can typically only be done in the data logger mainframe. This hardware inflexibility adds considerable cost to the total system price since the hidden cost of routing signal cables to the data logger can be many times its purchase price.

The Fluke 2280B connects the expansion chassis to the data logger over a high speed serial multi-drop communication link. Any type of input or output can be located near the signal source, reducing long runs of signal wire. For example, instead of running two hundred pairs of thermocouple extension wire 500 feet, only one run of inexpensive six conductor cable would be required. In addition to reducing installation costs, this distributed system concept also allows multiple A/D converters to be used, adding redundancy and higher sampling speeds while maintaining full accuracy and noise rejection.

## What Kind of Accuracy?

High accuracy is typically one of the major strengths of data loggers. However, measurement accuracy varies widely between data loggers. The following guidelines may be helpful when comparing accuracy specifications:

**Compare thermocouple accuracy.** The voltage output from thermocouples is very small; for example, a thermocouple measuring a temperature of 200°C would be outputting a signal of only about 7 millivolts. Thermocouples present one of the most difficult types of measurement to make and serve as an excellent benchmark for comparing data loggers.

**Noise rejection is very important.** Two types of electrical noise are usually present, common mode noise and normal mode noise. Common mode noise occurs when there is a voltage that appears on both wires of the measured signal. An obvious example would be a thermocouple directly in contact with a resistance heating element. Common mode noise generally occurs when either there is a difference between the ground planes of the measuring instrument and the sensor, or when voltages are induced in the signal wires as they pass near magnetic fields. Common mode noise is prevalent in both industrial and laboratory environments and is difficult to eliminate.

Normal mode noise occurs when additional voltage appears on only one of the wires of the measured signal. An example might be untwisted signal wires running parallel to an ac power line. A voltage differential in addition to the measured signal will be induced. As with common mode noise, normal mode noise can be difficult to eliminate.

The ability of the measuring instrument to ignore these error sources is stated by the common mode rejection ratio (CMRR) and the normal mode rejection ratio (NMRR) specifications. For every 20 dB of noise rejection, the error due to common or normal mode voltages will be reduced by a factor of 10. CMRR and NMRR specifications do vary drastically between loggers, and can easily overshadow the stated accuracy.

For example, two loggers have identical accuracy (0.01%), but data logger A has a CMRR of 120 dB, and data logger B has a CMRR of 160 dB. Each logger reads a thermocouple with an output of 20 mV with 115V of common mode voltage present.

Logger A	
base accuracy (0.01% x 20 mV)	= 2.0 $\mu$ V
common mode error (115 x 10 <sup>-6</sup> )	= 115.0 $\mu$ V
total error	= 117.0 $\mu$ V
Logger B	
base accuracy (0.01% x 20 mV)	= 2.0 $\mu$ V
common mode error (115 x 10 <sup>-8</sup> )	= 1.2 $\mu$ V
total error	= 3.2 $\mu$ V

**Don't confuse conformity with accuracy in thermocouple specifications.** Conformity error is the difference between the thermocouple linearization used and the tables published by NBS and says nothing about accuracy.

**Be sure that the operating temperature range and calibration period are the same for the loggers you are comparing.** Accuracy specifications are typically given over a temperature range for a period of time (i.e. 25°C to 35°C for 90 days). Accuracy can degrade very rapidly above or below the temperature range specified. Additionally, if you don't send your instruments in every three months for recalibration, then 1 year accuracy specifications are more meaningful than 90 day figures.

**Insist on Total Instrument Accuracy Specifications.** Total instrument accuracy includes all the measurement errors associated with the device and includes: warmup, measurement accuracy, linearization conformity, and reference junction compensation. It gives the truest measure of accuracy, forms the best measure for comparison and unfortunately, is omitted by many manufacturers.

(Reprinted from CPI 100)

# DATA LOGGERS

## 2280 SERIES

### 2280 SERIES Data Loggers

The 2280 SERIES, a family of advanced data loggers, combines high measurement accuracy, exceptional configurational flexibility, and computer-like power without requiring the user to write software. This family, composed of the 2285B Data Logger and the more powerful 2280B Data Logging System, offers solutions for demanding data acquisition and reporting problems.



2280B

### 2280B Data Logging System

- Fluke's most powerful data logger
- Expandable to 1500 channels
- Precision measurements and control
- Flexible report generation
- 12V operation for mobile or field use
- Pseudo-channels give computer power without writing software

The 2280B Data Logging System, Fluke's most powerful data logger, is expandable from a simple 20 channel data logger to a distributed 1500 point data acquisition system. The 2280B Data Logging System accepts all 2280 SERIES options, offers the ultimate in data logging power and flexibility, and when equipped with an Analog Output Option (-170), the 2280B can even be programmed to implement PID control.



2285B

### 2285B Data Logger

- Powerful, limited capabilities data logger
- Expandable to 100 channels
- Precision measurements
- Flexible report generation
- 12V operation for mobile or field use
- Pseudo-channels give computer power without writing software

For applications that do not require all the power or expansion capabilities of the 2280B Data Logging System, the 2285B Data Logger is a more economical solution. Expandable to 100 points, the 2285B accepts all 2280 SERIES options, except the Analog Output (-170), Counter/Totalizer (-167), Cartridge Tape (-214), and Advanced Math (-211) options.

### Programming Ease

Both the 2285B and 2280B are programmed by responding to a series of English-prompted menus. Simple front panel responses to the displayed questions configure the 2280 SERIES to perform the required tasks. Instead of limiting the user to pre-defined functions, or requiring the development of libraries of application software, the 2280 SERIES employ pseudo-channels. An exclusive 2280 SERIES feature, pseudo-channels allow any mathematical relationship between channels, such as group averages; or between a channel and time, such as rate of change; to be described as a simple algebraic equation. With pseudo-channels, application problems that previously required the power of a computer, and an investment in software, are now possible in a stand-alone data logger.

### Power to Get the Job Done

Accenting this computational power, the 2280 SERIES offer excellent documentation features. Each measurement channel, output channel or pseudo-channel can be uniquely identified with a 15 character label, clearly describing the point being logged. Adding further clarity, 6 character, user defined, engineering units for each point are a standard feature. Also standard is the ability to check every input, output or pseudo channel against alarm limits. Four high/low limits are available for each channel, and each limit can cause a user defined 40 character message describing the alarm condition to be recorded.

### Report Generation

The 2280 SERIES allows its recording function to be easily tailored to the requirements of the job. Collected data, the results of calculations, or outputs can be viewed on the bright, 40 character vacuum fluorescent display, or logged on the wide format 40 character internal printer. Adding further recording flexibility are two communication ports which can be configured with optional RS-232-C or IEEE-488 interfaces. An optional DC100 magnetic tape drive is also available for the 2280B Data Logging System, allowing 500K bytes of data and/or programs to be saved on each tape.

### For Demanding Environments

Applications that require more input or output points than can be housed in the mainframe are satisfied by using the 2281A Extender Chassis. These extender chassis are connected to the mainframe with a simple six twisted-pair cable, and communicate via a high speed, fault-tolerant, communication network. Since all communication is digital, signal integrity is assured in electrically noisy environments. Furthermore, any input or output options housed in an extender chassis have an operating range: -20°C to +70°C.



# DATA LOGGERS

## 2280 SERIES

### Portable Operation

Another standard feature is full operation from 12V dc power, making the 2280 SERIES a natural for mobile data acquisition. Connecting a 12V battery allows this dc operating mode to function as an uninterruptable power supply. The 2280 SERIES trickle charges the battery when on line power and bumplessly transfers to battery operation when line power fails, assuring measurement integrity for critical applications.

### Specifications

**Extender Chassis:** As many 2281As as needed

**Maximum Inputs & Outputs:**  $\leq 1500$  points per system (2280B);  $\leq 100$  points per system (2285B)

**Analog Inputs:**  $\leq 1500$  channels per system (2280B),  $\leq 100$  channels per system (2285B)

**Status, Binary, or BCD Inputs:**  $\leq 1500$  lines per system (2280B),  $\leq 100$  lines per system (2285B)

**Status Outputs:**  $\leq 1500$  points per system (2280B);  $\leq 100$  points per system (2285B)

**Alarm Outputs:**  $\leq 1500$  points per system (2280B);  $\leq 100$  points per system (2285B)

**Analog Outputs:**  $\leq 600$  points per system (2280B only)

**Computation Power:** Besides built-in thermocouple and RTD linearizations, the 2280 SERIES will handle equations involving addition, subtraction, multiplication, division, and parentheses. Advanced Math Option (-211) (2280B only) adds square root, exponent, logarithm, trigonometric, standard deviation, interpolation tables, logic functions, equal-to, less-than, greater-than, etc.

**Tasks:** Up to 10 independent, prioritized scan groups

**Scanning Speed:** Depends on the number of A-to-D Converter Options (-161) per system and the system configuration. Scanning dc voltage inputs for alarms at full accuracy:

Up to 16 channels per second with 1 A/D Option

Up to 30 channels per second with 2 A/D Options

Up to 42 channels per second with 3 A/D Options

Up to 65 channels per second with 5 A/D Options

**Temperature:** 0°C to 50°C operating (2280B/2285B); -20°C to 70°C operating (2281A)

**System Communications:** High speed digital data transferred between 2281As and a 2280B/2285B is via noise-immune twisted wire-pairs. May be linked in star and/or daisy-chain configurations

**Distance To Extender Chassis:** Any 2281A may be up to 1 km away from a 2280B/2285B

**Failures:** System component failures are reported as an alarm. All properly operating equipment continues with normal tasks

### 2280 SERIES Mainframe

**CPU:** Uses multiple 8-bit microprocessors with 128K bytes of ROM

**I/O Capacity:** Six slots for input and output options. One of the six slots must contain an A-to-D converter option when one or more analog input options is used. Each analog input option will scan 20 channels and each status or digital input or output option will handle 20 lines. If no A-to-D converter option is needed, each 2280B/2285B will handle up to 120 points of status inputs or outputs. Two additional plug-in slots are for any combination of one or two IEEE-488 or RS-232 options

**Program Memory:** 32K bytes (2280B); 20K bytes (2285B). Non-volatile. Battery back-up for at least 30 days, 90 days typical. Program may also be printed using internal printer or with optional interface to external devices

**Internal Printer:** Uses thermosensitive paper, 110 mm (4.4 in) wide. Up to 40 alphanumeric characters per line printed from 5x7 dot matrix, 2.6 lines per cm (6.7 lines per in). Each line printed below the previous line. Will plot one to four graphs from scanned or calculated data, instead of alphanumeric characters, using distinctive symbol for each graph in any of 276 discrete positions across width of paper. Automatic paper take-up reel prevents spilling and allows withdrawal of any printed portion for review

**Power:** 100, 120, 220, or 240V ac  $\pm 10\%$ , 50 or 60 Hz. Or 10.5 to 15V dc. Ac power will trickle-charge 12-volt battery for uninterrupted power. Less than 120W fully loaded

### DC100 Tape Drive Option (-214) (2280B only)

Used to store both scanned data and data logger programs. A single tape can contain multiple files of programs and/or data as the operator chooses. The tape is formatted with a directory which may be listed on the printer.

Four data compression formats are selectable for data recorded. Storage capacity is 500K bytes which is 12,500 to 50,000 channel readings dependent upon format selection.

Recorded data may be transferred to the internal printer or peripheral devices. The data transfer function permits data recorded at full speed to be transferred to a slower device such as the internal printer. The operator may transfer an entire file or part of a file based upon the time the data was recorded. For example, if a file contains data from a 24-hour test, the operator may only be interested in printing information gathered between 2:00 p.m. and 3:00 p.m. the operator enters these "start" and "stop" times and the 2280B searches for and transfers only those scans which were executed in the 2 to 3 p.m. time span.

### Advanced Math Option (-211) (2280B only)

**Functions:** Absolute value, square root, exponential, sine, cosine, tangent, arc sine, arc cosine, arc tangent, common logarithm, natural logarithm, ex, exponentiation, integer part, maximum value, minimum value, standard deviation, elapsed time

**Logical Operators:** AND, OR, NOT, EXCLUSIVE OR

**Relational Operators:**  $<$ ,  $\leq$ ,  $>$ ,  $\geq$ ,  $=$ ,  $\neq$

**Interpolation Tables:**  $\leq 10$ , user-entered. Number of points per table is limited only by system memory

### 2281A Extender Chassis

**Capacity:** Same plug-in options as 2280B/2285B

**Power:** Normally supplied by 2280B/2285B via 2281A-402 cable or equal. An optional built in power supply (2281A-431) may also be used and may be required for remote operation

**Operating Temperature:** -20°C to +70°C

### High Performance A/D Converter Option (-161)

One per 2280B/2285B and 2281A required for any analog measurement inputs.

**Dynamic Range:** 80,000 counts

**Ranges:**  $\pm 64$  mV,  $\pm 512$  mV,  $\pm 8$ V, and  $\pm 64$ V dc

**Resolution:** 1  $\mu$ V on 64 mV range, 10  $\mu$ V on 512 mV range, 100  $\mu$ V on 8V range, 1 mV on 64V range

**Common Mode Noise Rejection:**  $\geq 170$  dB at 50 or 60 Hz  $\pm 0.1\%$ ;  $\geq 160$  dB at dc; 100 ohm unbalance

**Normal Mode Noise Rejection:**  $\geq 60$  dB at 50 or 60 Hz  $\pm 0.1\%$

**Operating Temperature:** -20°C to +70°C

## 2280B/2285B &amp; 2281A Input Options

For These Inputs	Use Connector Option	With Scanner Option	Maximum Inputs per Scanner
Thermocouples	-175	-162 **	20
DC Voltage	-176 or -175	-162 **	20
DC Current	-171	-162 **	20
AC & DC Voltage	-160	-162 **	10 AC, 10 DC
RTDs or Ohms	-177	-163 **	20
RTDs, Ohms, Strain	-174*	-164 **	20
Status	-179	-168	20
BCD Digits	-179	-168	5
Binary	-179	-168	17 Bits & Sign
Frequency	-179	-167/AA	4
Frequency	none reqd.	-167	6 (2280B only)
Totalize Events	-179	-167/AA	4
Totalize Events	none reqd.	-167	6 (2280B only)

\* A dc voltage scanner and companion connector Option (-162 and -176) are also required for each Transducer Excitation Option -164 used for RTDs, Ohms, or Strain measurements

\*\* A/D Converter (-161) required in chassis

## Voltage, Thermocouple Current Inputs

## Thermocouple and DC Scanner Option (-162)

**Channels:** Twenty per option. One 3-pole dry reed relay for each channel (Hi, Lo, Shield)

**Ranges:** 64 mV, 512 mV, 8V, and 64V, software-selectable

**Input Impedance:**  $\geq 200$  M $\Omega$  on 64 mV and 512 mV ranges, 10 M $\Omega$  on 8V, and 64V ranges

**Thermal Offset:**  $\leq 1$   $\mu$ V each channel

**Maximum Input Voltage:** 250V dc or rms ac between Hi and Lo terminals  
**Maximum Common Mode Voltage:** 250V dc or rms ac between Hi or Lo and ground or between two adjacent channels

## Voltage Input Connector Option (-176)

**Channels:** Twenty 3-wire sets of screw terminals for dc voltage input wires

**Maximum Measureable Voltage:** 64V dc

**Compatibility:** Plugs onto scanner module, Option -162

DC Voltage Accuracy  $\pm$ (% of R<sub>dg</sub> + Counts)\*

Range	90 Days 15°C to 35°C	1 Year 15°C to 35°C	1 Year** -20°C to 70°C
64 mV	0.005% + 7	0.01% + 8	0.03% + 9
512 mV	0.005% + 3	0.01% + 4	0.03% + 5
8V	0.005% + 7	0.01% + 8	0.03% + 9
64V	0.009% + 3	0.02% + 4	0.05% + 5

\* Total instrument accuracy using Option -162 and -176

\*\* A/D Converter must be in 2281A for operation to -20°C or 70°C

## Isothermal Input Connector Option (-175)

**Channels:** Twenty 3-wire sets of screw terminals for thermocouple or voltage input wires. Large, insulated aluminum block serves as reference junction

**Maximum Measurable Voltage:** 64V dc

**Compatibility:** Plugs onto scanner module, Option -162

## Temperature Measurement Accuracy, Thermocouples\*

Thermo-couple Type	Measured Temperature °C	Maximum Instrument Error ( $\pm$ °C)		
		90 Days 15°C-35°C	1 Year 15°C-35°C	1 Year** -20°C-70°C
J NBS	-200 to -100	0.45	0.5	1.6
	-100 to +200	0.35	0.4	0.9
	+200 to +760	0.45	0.5	0.75
J DIN	-200 to -100	0.45	0.5	1.6
	-100 to +200	0.35	0.4	0.9
	+200 to +900	0.45	0.5	0.75
K NBS	-225 to -100	0.45	0.5	1.9
	-100 to +200	0.35	0.4	1.0
	+200 to +1350	0.5	0.6	1.25
T NBS	-230 to -100	0.45	0.5	1.9
	-100 to +200	0.35	0.4	1.0
	+200 to +400	0.45	0.5	0.6
T DIN	-200 to -100	0.45	0.5	1.9
	-100 to +200	0.35	0.4	1.0
	+200 to +600	0.45	0.5	1.25
E NBS	-250 to -100	0.45	0.5	1.5
	-100 to +250	0.35	0.4	0.9
	+250 to +840	0.45	0.6	0.85
R NBS	0 to +200	1.15	1.35	2.2
	+200 to +1767	0.95	1.15	1.6
S NBS	0 to +200	1.15	1.35	2.2
	+200 to +1767	0.95	1.15	1.6
B NBS	+200 to +500	1.05	1.25	10.0
	+500 to +1820	1.05	1.25	3.8
N*** NBS	-200 to -100	0.45	0.5	1.9
	-100 to +200	0.35	0.4	1.0
	+200 to +400	0.5	0.6	1.25
C	0 to +2315	0.85	1.05	1.8

\* Total Instrument Accuracy using Option -162 and -175 in 2281A chassis

\*\* A/D Converter must be in 2281A for operation to -20°C or 70°C

\*\*\* For AWG 28 wire

## Current Input Connector Option (-171)

**Channels:** Twenty 2-wire pairs of screw terminals for current inputs. Typically for 4 to 20 mA or 10 to 50 mA inputs

**Maximum Measurable Current:** 64 mA per channel

**Current-Sense Resistors:** 8 $\Omega$   $\pm$ 0.02 $\Omega$

**DC Current Accuracy:**  $\pm$ (0.25% of reading + 4 counts) for 90 days

**Compatibility:** Plugs onto scanner module, Option -162

## AC Voltage Input Connector Option (-160)

**Channels:** Ten 2-wire sets of terminals for ac voltage and ten for dc voltage

**Voltage Range for AC:** 5V rms to 250V rms measurable. 250V rms ac or dc maximum between any two terminals on the assembly

**Frequency Range for AC:** 45 Hz to 450 Hz

**Accuracy for AC:** 1% of reading  $\pm$ 0.1V for 90 days. Average-responding conversion; calibrated for rms value of sinewaves

**Voltage Range for DC:** 64V maximum measurable. 250V rms ac or dc maximum between any two terminals on the assembly

**Accuracy for DC:** Same as for Option -162 with Option -176

**Compatibility:** Plugs onto scanner module, Option -162

## RTDs &amp; Ohms Scanner Option (-163)

A 20-channel scanner module for precision measurements of RTDs and/or resistances.

**Measurement Modes:** 4-wire or one of two 3-wire modes (both with lead-wire resistance compensation). One 3-wire mode eliminates reed resistance errors

**Ranges:** Three; 256 $\Omega$ , 2048 $\Omega$ , and 64 k $\Omega$  (or user selectable), software programmed

**Current Sources:** Two; 1 mA and 32  $\mu$ A (or user selectable)



# DATA LOGGERS

## 2280 SERIES

**Input Isolation:** 250V dc or ac rms between separate scanner modules. 250V dc or ac rms between the two decades of channels within a scanner module. 250V dc or ac rms between all channels in two of the three measurement modes. 30V dc or 24V ac rms between terminals of a channel

### RTDs & Ohms Connector Option (-177)

Plugs onto the Option -163 circuit card module. Contains five terminals per channel for 20 channels of RTD and resistance input wires.

### RTD Specifications, Five Classes

- A** — User-defined high resolution Platinum RTDs
- B** — High resolution Platinum 385 DIN RTDs
- C** — User-defined high temperature Platinum RTDs
- D** — High temperature Platinum 385 DIN RTDs
- E** — Ten Ohm Copper RTDs

RTD Class	Maximum Temperature	System		
		Resolution	Accuracy*	Repeatability*
A	420°C	0.006°C	0.1°C**	0.04C**
B	420°C	0.006°C	0.11°C**	0.04°C**
C		0.05°C	0.27°C***	0.16°C***
D		0.05°C	0.28°C***	0.16°C***
E		0.06°C	0.3°C	0.17°C

\*Total Instrument Accuracy, 15°C to 35°C for 90 days

\*\*RTD Temperature ≤150°C

\*\*\*RTD Temperature ≤600°C

Note: Classes A and C allow the user to perform an ice point initialization and improve total system accuracy to be the sum of repeatability plus 0.02°C for 390 and 392 RTDs or 0.03°C for 385 DIN RTDs plus RTD conformity error

### Ohms Specifications

Resolution	±(% of Rdg + Ω)	
	Accuracy	Repeatability
2.4 MΩ	0.017% + 5.7 MΩ	0.0065% + 5.7 MΩ
19 MΩ	0.017% ±38 MΩ	0.0060% ±38 MΩ
0.6Ω	0.06% ±1.22Ω	0.0075% ±1.22Ω

\*Total Instrument Accuracy, 15°C to 35°C for 90 days

### RTDs, Ohms, & Strain Excitation Option (-164)

Five constant current sources for measuring RTDs and/or resistances and a constant voltage source for measuring strain. Channels are configurable in groups of four for either voltage or current excitation. These current sources are factory configured for 1 mA output and are user-modifiable for other ranges. The voltage supply is switch-selectable for either 2V or 4V and can supply up to 250 mA. A bridge completion network is provided for ½- and ¼-bridge strain gages. Requires Connector Option -174. Option -174 and -164 plug together and occupy one I/O slot in a 2280B/2285B or 2281A, usually adjacent to the corresponding Scanner Option -162.

### RTDs, Ohms, & Strain Connector Option (-174)

**Channels:** Twenty 5-wire sets of screw terminals for connections to RTDs or strain gages. Terminals also provide access to the bridge completion network of Option -164

**Compatibility:** Plugs onto excitation module, Option -164

### Ohms Mode Specifications (Option -164, -174)

Max Resistance	Accuracy* ±(% of Rdg + mΩ)	Resolution	Excitation Current
64Ω	0.02% + 7	1 mΩ	1 mA
512Ω	0.02% + 30	10 mΩ	1 mA
Other ranges that may be set by user			
5.12 kΩ	Depends on user's resistor	0.1Ω	0.1 mA
51.2 kΩ		1Ω	0.01 mA

\*Total Instrument Accuracy, 15°C to 35°C for 90 days

**Total System Accuracy:** ±(0.02% of reading) for 90 days, 13°C to 33°C, four-wire configuration

### RTD Mode Specifications (Option -164, -174)

RTD channel definitions allow you to tailor the instrument to the known characteristics of your probe with a conformity error less than 0.05°C

**Resolution:** 0.02°C

### Temperature Measurement Accuracy\*

RTD Type & Range	Maximum Instrument Error
100 Platinum RTDs	
-200°C to +200°C	0.1°C
200°C to 600°C	0.15°C
10 Copper RTDs	
-75°C to +150°C	1.0°C

\*Total Instrument Accuracy. For 90 days, 13°C to 33°C

**Repeatability:** ±0.08°C for Platinum RTDs, ±0.2°C for Copper RTDs  
**Temperature Coefficient:** ±10 ppm/°C

### Strain Mode Specifications (Option -164, -174)

#### Full-Bridge Strain

Capacity: Twenty 350Ω or 120Ω bridges with 2V supply or ten 120Ω bridges with 4V supply

Resolution: 0.25 microstrain

Total System Accuracy: ±(0.05% of rdg + 2 microstrain)\*

Temperature Coefficient: ±10 ppm/°C

#### ½-Bridge Strain

Capacity: Twenty 350Ω or 120Ω bridges

Resolution: 0.5 microstrain

Total System Accuracy: ±(0.05% of rdg + 13 microstrain)\*

Temperature Coefficient: ±15 ppm/°C

#### ¼-Bridge Strain

Capacity: Twenty bridges

Resolution: 0.5 microstrain

Total System Accuracy: ±(0.05% + 25 microstrain)

Temperature Coefficient: ±20 ppm/°C

\*20°C to 30°C for 90 days

### Frequency Measurement and Event Totalization (-167) (2280B only)

**Channels:** Six

**Functions:** Event counting and frequency measurement, selectable per channel pair

#### Inputs

**Signal Types:** TTL, CMOS, contacts, analog waveforms

**Adjustments:** Threshold, deadband, and debouncing

**Isolation:** Each group of six channels isolated from ground

**Frequency Measurement:** 400 kHz maximum frequency, 0.001% resolution

#### Event Counting

**Maximum counts:** 8,388,607

**Counting Rate:** DC to 400 kHz

**Operation:** Count is reset after each scan. Pseudo channels are used for count accumulation

**Connector:** Screw terminal connector supplied

### Frequency Measurement and Event Totalization (-167/AA)

**Channels:** Four

**Functions:** Event counting and frequency; selectable by channel inputs

**Signal Types:** TTL or contacts

**Adjustments:** None

**Isolation:** Each group of four channels isolated from ground

**Frequency Measurement:** 1000 Hz maximum frequency, 1 Hz resolution

#### Event Counting

**Maximum Counts:** 65,534

**Operation:** Count is reset after each scan. Pseudo channels are used for count accumulation

**Counting Rate:** DC to 1000 Hz

**Connector:** Uses -179 Digital/Status Input Connector (not supplied)

## DATA LOGGERS

## 2280 SERIES

## Digital &amp; Status Inputs &amp; Outputs

**Digital Input/Output Module Option (-168)**

For controlling up to 20 input or output lines. Handles either 20 status inputs, 5 groups of 4-wire BCD digit inputs, or one 17-bit binary number (and sign). Or handles 20 status outputs.

**Inputs:** Zero volts or contact closures for low, +6 volts maximum for high

**Common Mode Voltage:** 30V rms ac or dc, maximum

**Outputs:** Open collector NPN transistors, diode clamped, 28V maximum, 100 mA at 1V

**Compatibility:** Requires connector Option -179 for inputs or connector Option -169 for outputs

**Digital/Status Input Connector Option (-179)**

**Channels:** Twenty 2-wire pairs of terminals for Option -168 plus terminals to select BCD and binary clocking format

**Status Output Connector Option (-169)**

**Channels:** Twenty 2-wire pairs of terminals for Option -168. Also terminal provided for clamping diodes when used to drive relays

## Analog Option

**Analog Output Option (-170) (2280B only)**

**Outputs:** Four per module. Each output has a selectable choice of ranges: -5V to +5V, 0V to +10V, or 4 to 20 mA

**Resolution:** 2.44 mV in voltage ranges, 3.9  $\mu$ A in current range

**Accuracy:**  $\pm 0.1\%$  of range for 90 days, 15°C to 35°C

**Isolation:** Each group of four channels isolated from ground

**Compliance Current:** 5 mA in voltage mode

**Compliance Voltage:** 10V in current mode

**Temperature Range:** -20°C to +70°C, operating in 2281A

**Connector:** Included with option

## Other 2280 SERIES Options

**RS-232-C Interface Option (-341)**

Data may be output via the RS-232-C interface at 110 to 19,200 baud, selectable from the front panel. May be configured to operate on a 20 mA current loop and can serve as the 20 mA current source.

Other RS-232-C parameters selected via the front panel include: Data compression format, channel readings per line, start of data sequence, end of data sequence, line termination sequence, and parity.

Acts as a terminal (DTE) or, with an included adapter, as a modem (DCE), or both (with two Options).

**Baud:** 110, 300, 600, 1200, 2400, 4800, 9600, or 19,200

**Parity:** Odd, even, or neither

**IEEE-488 Interface Option (-342)**

Operates as either a talker only, or talker/listener. Easy-to-read thumbwheel switches are used to set the IEEE-488 address and are accessible from the rear panel. Data output parameters selected from the front panel include data compression format and the number of channel readings per line.

**Repertoire in Port A:** SH1, AH1, T5, L4, SR1, RL1, DC1, E2

**Repertoire in Port B:** SH1, AH1, T5, L4, SR1, and E2

**2281A Power Supply Option (-431)**

Although power for a 2281A is normally supplied by a 2280B/2285B via a 2281A-402 Cable, a built in power supply Option (2281A-431) is available and is required when the distance to a 2281A and/or the current drain of the 2281A is heavy because of the number of options installed. The 2281A-431 power supply will operate on ac power or a 12V or 24V dc supply, either of which will trickle charge a 12V battery for battery backup in the event of a power failure. Ask your Fluke Sales Office or Representative for Configuration Form F605 to determine what options may be installed in a 2281A at what distances without Option 2281A-431.

**Operating Temperature:** -20°C to +70°C

## 2280 SERIES Accessory Descriptions

**Y2042:** Package of five DC 100 tape cartridges certified for use with Tape Drive Unit (Option -214).

**Y2044:** Rack Slide Kit for mounting 2280 Series or 2281A in a standard 42-cm (19-inch) rack with 61-cm (24-inch) depth. Contains all necessary hardware including a Y2045. Height is 22.2 cm (8.75 in).

**Y2045:** A rack mounting kit for 2280 Series or 2281A. Does not include rack slides. Fits standard 42-cm (19-inch) rack with 61-cm (24-inch) depth. Height is 22.2 cm (8.75 in).

**Y2046:** Package of ten rolls of thermal print paper for 2280B/2285B's printer/plotter. Capacity is 4000 lines of print, 12,000 channel readings using compressed mode.

**Y2047:** Three-connector device needed for "star" configurations.

**A22-300:** A heavy-duty transit case constructed from high-density polyethylene specifically for the 2280B/2285B. Foam padding, cut to conform to the 2280B/2285B mainframe, insulates the data logger from shock encountered in shipping. Dimensions: 30.5 cm H x 64 cm W x 76.8 cm D (12 in x 25.1 in x 30.1 in).

**A22-301:** A tape reader compatible with the 2280B's DC 100 tapes. It will output data via RS-232-C (110-9600 baud), or 20 mA current loop, 115 or 230V, 50 Hz or 60 Hz power.

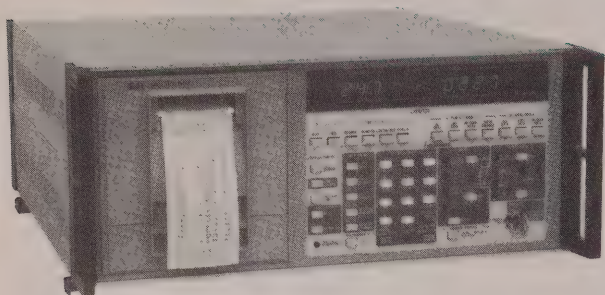
## 2280 SERIES Ordering Information

See page 196.



# DATA LOGGERS

## 2240C



2240C

### 2240C Data Logger

- Expandable to 1000 channels
- Over 4000 installed worldwide
- Easy to configure and program
- Input and log thermocouples, RTDs, DCV, ACV, dc current, and BCD
- Up to 4 user programmed alarms per channels
- Remote control via IEEE-488 or RS-232-C

The 2240C, like its well known predecessors the 2240B and 2240A, handles most data logging requirements yet sells for a medium price. A large variety of options makes it possible to configure each system to closely match the size and unique character of individual requirements.

Up to 60 input channels may be scanned with a stand-alone 2240C. Up to 1000 may be scanned in a 2240C system using 2201A, 2202A, and/or 2203A Scanner Extenders.

Programming is accomplished from the front panel and no knowledge of computer programming is needed. The keys are grouped and color coded to make it easy to set up and operate the data logger for each application. A front panel lock allows a program to be secured from accidental modification by an operator.

One group of keys lets you select the output mode for the printer and any peripheral: You can scan and record all data, record data only when an out-of-limit transition occurs, or record data periodically at preselected intervals.

Another group lets you identify the first and last channel to be scanned, the time interval between periodic scans, and a particular channel that may be monitored. You can select fixed heading data to appear at the start of each scan and cause a printout of the contents of the program memory to help you change or document a program.

Other keys let you establish the measurement functions and limits assigned to each channel and to skip any channel in a sequence. A "repeat" key makes it simple to duplicate the function and limits of the previous address.

### Specifications

**Mainframes:** One 2240C per system; as many 2201A, 2202A, and/or 2203A Extender Chassis as needed if more than 60 channels are to be scanned

**Maximum Analog Inputs:** ≤1000 per system

**Maximum BCD Inputs:** ≤Three 9-digit sets

**Alarm Outputs:** ≤60 per system, 30 per Option -23, open collector outputs. ≤4 relay outputs, two for each Option -23 installed

**Computation Power:** Capability of measuring and linearizing the outputs of up to eight different types of thermocouples plus three types of RTDs plus scaling the output of 4 to 20 mA current

transmitters. Three different combinations of these choices are available: Group I, Group II, or Group III (Option -43, -44, or -45). Up to 30 user-programmable  $mx+b$  scaling functions are available with Option -40. Up to 30 single channel *time averaging* functions and/or multiple channel *group averaging* functions are available with Option -42. Up to 60 user programmable limit values are selectable as high- or low-limit set points for channel data with Option -41  
**Distance Between Mainframes:** ≤15 meters (50 feet) to 2201A; 1.8 meter (6-foot) cable standard with 2201A. ≤457 meters (1500 feet) to most remote 2202A or 2203A

#### 2240C Mainframe

**Capacity:** Six slots for input options plus 3 slots for digital input, alarm output, and communications options

**Scanning Speed:** ≤15 channels per second

**Internal Printer:** A 16-column impact printer for fan-fold 5.7 cm (2¼-in) paper. Prints up to 2.5 lines per second, each successive line above the other. For recording program steps as well as logging data

**Program Memory:** Sufficient for 1000 channels. Non-volatile

**Temperature:** 0°C to 50°C, operating; -40°C to 60°C, non-operating

**Relative Humidity:** ≤80%, non-condensing, to 35°C; ≤70%, non-condensing, to 50°C

**Shock and Vibration:** Meets requirements of MIL-T-28800C

**Power:** 100, 115, or 230V ac ±10%, 50 or 60 Hz; less than 50W, maximum. Internal switches for 115 or 230V operation

**Size:** 15.4 cm H x 37.5 cm W x 49.5 cm L (7 in x 17 in x 22.5 in)

**Weight:** Approximately 18 kg (40 lb), depending on options

#### 2201A Scanner Extender

**Capacity:** 12 slots for scanner cards (120 channels). 2201A needed only if more than six scanner cards (60 channels) are required. More than one 2201A may be used for up to 1000 channels

**Power:** Supplied by 2240C, 2202A, or 2203A. Normal cable length is 1.8 meters (6 feet). Cables up to 15 meters (50 feet) may be used

#### 2202A Remote Scanner Extender

**Capacity:** 10 slots for scanner cards (100 channels). Similar to 2201A but recommended for remote data acquisition — up to 457 meters (1500 feet) from 2240C

**Power:** Has own power supply. Operates from nominal 120V or 240V ac power line

#### 2203A RTD Extender

Similar to 2202A except for RTDs only and 1.8 meter (6 foot) cable is standard. Operates up to 457 meters (1500 feet) from data logger

**Capacity:** 10 slots for Option -04 RTD Scanner Cards and Option -03 Connectors (100 channels). Separate Ro calibration potentiometer for each RTD

**Power:** Has own power supply. Operates from nominal 120V or 240V ac power line

#### High Performance A/D Converter

Each 2240C includes an analog-to-digital converter. It is a plug-in circuit that measures and digitizes all analog data from the input scanners

**Measurement Speed:** 3 or 15 readings per second, switch-selectable

**Dynamic Range:** 40,000 counts

**Ranges:** ±40 mV, ±400 mV, ±4V, and ±40V

**Resolution:** 1 μV on 40 mV range

**Common Mode Noise Rejection:** ≥140 dB at 50 and 60 Hz ±0.1%, ≥120 dB at dc, with 1 kΩ unbalance, at slow speed. At high speed the same except 110 dB at 50 and 60 Hz

**Common Mode Voltage:** ±170V dc or peak ac, system max

**Normal Mode Noise Rejection:** ≥70 dB at 50 or 60 Hz ±0.1%, at slow speed. At high speed ≥55 dB

**Reference Voltages:** 2V and 0.02V at jacks in rear

**Reference Voltage Accuracy:** ±0.02% for 90 days from 20°C to 30°C

## 2240C Input Options

For These Inputs	Use Connector Option	With Scanner Option	Maximum Inputs per Scanner
Thermocouples* & Low Voltage	-08	-06	10
Low DC Voltage	-07 or -08	-06	10
DC Voltage	-07 or -08	-05 or -06	10
AC Voltage	-07 or -08	-33/AL	8
1-5 mA DC	-28	-05 or -06	10
4-20 mA DC	-29	-05 or -06	10
10-50 mA DC	-30	-05 or -06	10
RTDs*	-03	-04**	10
RTDs*	-03	-33	8
BCD Digits	None	-16	9

\* Linearization Option -43, -44, or -45 also required

\*\* For 2203A RTD Scanner Chassis

## Voltage and Thermocouple Inputs

## Low Level Scanner Option (-06)

Ten channels per option. Ten 3-wire dry reed relays (Hi, Lo, shield).

Life: Rated for >10<sup>8</sup> operations with ≤50V ac rms applied;

Thermal Offset: &lt;1 μV per channel

Maximum Voltage: ±170V dc or peak ac between any input terminal and system ground or other terminal

## General Purpose Scanner Option (-05)

A 10-channel, two-wire relay scanner designed for general purpose dc input applications. A common guard input is provided for all ten channels and its relay is energized when any one of the ten channel relays is energized. Voltage offsets due to scanner relay characteristics (thermal emf, contact resistance, etc.) are less than 10 μV.

## Solder Pin Connector Option (-07)

A 30-pin card-edge connector. Each of 10 possible three-wire inputs is soldered directly to the connector pins. This connector is recommended for general purpose ac or dc voltage measurements. Compatible with Option -05 or -06.

## DC Voltage Accuracy: ±(% Rdg + Volts)\*

Range	90 Days 20°C to 30°C		1 Year 20°C to 30°C	
	2.5 Rdgs/Sec	15 Rdgs/Sec	2.5 Rdgs/Sec	15 Rdgs/Sec
40 mV	0.01+3 μV	0.01+4.2 μV	0.015+6 μV	0.015+10 μV
400 mV	0.01+21 μV	0.01+33 μV	0.015+42 μV	0.015+64 μV
4V	0.01+0.2 mV	0.01+0.32 mV	0.015+0.4 mV	0.015+0.6 mV
40V	0.01+2 mV	0.01+3.2 mV	0.015+4 mV	0.015+6 mV

\*Total Instrument Accuracy, using Option -06 and -08

## Isothermal Connector Option (-08)

A card-edge connector assembly designed for use in making thermocouple temperature measurements and/or low level voltage measurements. Intended to be plugged onto Scanner Option -06. Ten 3-wire sets of screw terminals. Any combination of dc voltage and/or thermocouple types can be assigned as inputs.

## Temperature Measurement Accuracy, Thermocouples\*

Thermo-couple Type	Measured Temperature °C	Maximum Instrument Error (±°C)		
		90 Days 20°C to 30°C		1 Year 15°C to 35°C
		Rdgs/Sec 2.5	Rdgs/Sec 15	Rdgs/Sec 2.5
J NBS	-202 to 0 0 to +760 +760 to +1205	0.6° 0.4° 0.5°	0.7° 0.5° 0.6°	0.7° 0.5° 0.6°
J DIN	-200 to 0 0 to 900	0.3°	0.4°	0.5°
K NBS	-202 to -172 -172 to -130 -130 to 0 0 to +260 +260 to +1370	0.7° 0.6° 0.5° 0.4° 0.5°	0.8° 0.7° 0.6° 0.5° 0.6°	0.9° 0.8° 0.6° 0.5° 0.6°
K DIN	0 to 260 260 to 1300	0.3° 0.4°	0.3° 0.5°	0.6° 0.6°
T NBS	-202 to -130 -130 to 0 0 to +400	0.6° 0.5° 0.4°	0.8° 0.6° 0.5°	0.8° 0.7° 0.5°
T DIN	-200 to -130 -130 to 0 0 to 600	0.3° 0.3° 0.2°	0.4° 0.3° 0.2°	0.5° 0.3° 0.3°
E NBS	-202 to 0 0 to +260 +260 to +960	0.5° 0.4° 0.4°	0.6° 0.5° 0.5°	0.6° 0.5° 0.5°
R NBS	0 to +260 +260 to +350 +350 to +1760	1.5° 1.0° 1.0°	2.2° 1.2° 1.4°	2.2° 1.4° 1.4°
S NBS	0 to +260 +260 to +550 +550 to +1760	1.5° 1.0° 1.0°	2.2° 1.2° 1.4°	2.2° 1.4° 1.4°
S DIN	0 to 260 260 to 1600	0.7° 0.6°	0.9° 0.7°	1.1° 0.8°
B NBS	+480 to +1000 +1000 to +1820	1.6° 1.2°	2.4° 1.6°	2.4° 1.6°
C (W5)	0 to +2000 +2000 to +2320	0.7° 9.0°	1.0° 9.5°	3.0° 9.5°
D (W3)	0 to +260 +260 to +2000 +2000 to +2320	0.8° 0.7° 12.0°	1.0° 1.0° 12.5°	1.0° 1.0° 12.5°
G	+210 to +420 +420 to +2000 +2000 to +2320	1.0° 0.8° 8.0°	1.4° 1.0° 8.5°	1.4° 1.2° 8.5°
N	0 to 440 440 to 1290	0.2° 0.3°	0.3° 0.4°	0.4° 0.5°

\* Total Instrument Accuracy, using Option -06 and -08 and appropriate Scaling Option (-43, -44, or -45 in 2240C). Request Bulletin B0005 for a detailed discussion of accuracy.



# DATA LOGGERS

## 2240C

### DC Current Inputs

#### Current Connector Options (-28, -29, -30)

Current is measured using a voltage input scanner and attaching one of three current input connector options, depending on the current range: 1 to 5 mA, 4 to 20 mA, or 10 to 50 mA. Voltage is sensed by passing the input currents through separate precision resistors and measuring the voltage-drop across each resistor.

Option -28 is for 1 to 5 mA current transmitters. Shunt resistors: 60 $\Omega$ .

Option -29 is for 4 to 20 mA current transmitters. Shunt resistors: 15 $\Omega$ .

Option -30 is for 10 to 50 mA current transmitters. Shunt resistors: 6 $\Omega$ .

**Current Measurement Accuracy:**  $\pm 0.1\%$  of the reading

### AC Inputs

#### AC Voltage Scanner Option (-33/AL)

An 8-channel scanner card with two switch selectable voltage ranges: 4V and 120V rms. Measurements are average-responding and indicate the rms value of sine waves. Requires Connector Option -07 or -08.

**AC Voltage Accuracy:**  $\pm(\% \text{ Rdg} + \text{mV})$

Frequency Range	90 Days, 20°C to 30°C	
	4V Range	120V Range
<b>3 Readings Per Second</b>		
40 Hz - 100 Hz	0.5% + 0.5	0.5% + 20
100 Hz - 20 kHz	0.2% + 0.3	0.5% + 20
50 Hz or 60 Hz	0.2% + 0.5	0.5% + 20
<b>15 Readings Per Second</b>		
40 Hz - 100 Hz	3% + 3	3% + 20
100 Hz - 20 kHz	1% + 0.5	1% + 20
50 or 60 Hz	1% + 1	1% + 20

### RTD Inputs

#### RTD Scanner Option (-04)

A 10-channel scanner which operates only in a Model 2203A RTD Scanner Chassis. Four-wire configurations plus one guard wire common to all channels. Up to 10 scanners can be installed in a single 2203A to scan up to 100 points. A constant current source supplies excitation for 100 $\Omega$  RTDs, and an  $R_0$  calibration adjustment is provided for each.

#### RTD Scanner Option (-33)

Eight channels per option. Operates in 2240C, 2201A, or 2202A chassis. Four-wire configurations plus one guard wire common to all channels. Switched current source excites RTD being scanned. Separate calibration adjustment for each channel. See specifications with Option -04, above.

#### RTD Connector Option (-03)

A card-edge connector assembly which plugs onto an RTD Scanner Option. Four screw-terminals for each input channel for 3-wire or 4-wire RTDs. Terminals are HI, LO, S+, and S-.

### Temperature Measurement Accuracy, RTDs\*

Temperature Range with 100 $\Omega$ Platinum RTD	Maximum Instrument Error ( $\pm^\circ\text{C}$ )		
	90 Days 20°C to 30°C		1 Year 15° to 35°C
	Rdgs/Sec 2.5	15	Rdgs/Sec 2.5
-200°C to +450°C	0.3°C	0.4°C	0.4°C
+450°C to +800°C	0.3°C	0.4°C	0.6°C
<b>With 10<math>\Omega</math> Copper</b>			
-75°C to 150°C	0.15°C	0.2°C	0.25°C

\* Total Instrument Accuracy, using Option -03 and -33 (or -04) using 4-wire configuration

#### For Platinum RTDs

Ice Point Resistance: 100 $\Omega \pm 0.8\%$  (standard)

Temperature Range: -200°C to +800°C

Linearization Conformity: 0.035°C, 0.063°F

Resolution: 0.1°C, 0.1°F

#### For Copper RTDs

Resistance: 9.024 $\Omega$ , 10 $\Omega$  at 25°C

Temperature Range: -75°C to +150°C

Linearization Conformity: 0.002°C, 0.001°F

Resolution: 0.03°C, 0.05°F

Requires: Special 3-wire scanner

#### For Nickel RTDs

Ice Point Resistance: 120 $\Omega$

Temperature Range: -20°C to +285°C

Linearization Conformity: 0.05°C, 0.09°F

### BCD Inputs

#### Digital Input Option (-16)

This circuit card accepts up to nine digits of BCD input data for display as supplementary heading data. No separate connector option is required.

### Other 2240C Options

Option	Description	Used With	
		2240C	2200B
<b>Temperature Linearization &amp; Scaling</b>			
-43	Group I	Yes	No
-44	Group II	Yes	No
-45	Group III	Yes	No
<b>Scaling &amp; Conditioning</b>			
-40	mx+b Scaling	Yes	No
-42	Data Averaging	Yes	No
-32	Dual Interval Scan	Yes	No
<b>Limits and Alarms</b>			
-41	Alarms Setpoints	Yes	No
-23	Alarms Outputs	Yes	Yes
<b>Communications Interfaces</b>			
-12	RS-232-C	Yes	Yes
-14	Magnetic Tape	Yes	Yes
<b>Remote Programmable Interfaces</b>			
-15	IEEE-488	Yes	No
-17	RS-232-C	Yes	No

## Temperature Linearization & Scaling

### Temperature & Scaling Options (-43, -44, -45)

These options provide a choice of thermocouple linearizations, RTD linearizations, and a 4 to 10 mA (0% to 100%) current transmitter scaling operation.

Option -43 has NBS linearizations for J,K,T,S,R,B,E and C type thermocouples and 385 Pt and 390 Pt RTDs plus 0 to 100% input scaling for current loops.

Option -44 has both NBS and European (DIN) linearizations for J,K,T, and S thermocouples and 385 Pt and 392 Pt RTDs plus 0 to 100% input scaling for current loops.

Option -45 has linearizations for J,K,T,S,N,D, and G thermocouples and 385 Pt, 120Ω Ni, and 10Ω Cu RTDs plus 0 to 100% input scaling for current loops.

Only one of the above options may be installed at one time.

## Scaling and Conditioning

### mX+b Scaling Option (-40)

Provides 30 user-programmable mX+b scaling functions for any or all 1000 possible channels. A table of engineering unit notations is included which allows assignment of engineering units to scaled input data for readout on the printer.

### Data Averaging Option (-42)

Offers single-channel *time averaging* and multi-channel *group averaging*. Time averaging applies to up to 30 single channels with a selectable "averaging window" of up to 99 successive readings. Group averaging applies to up to 30 groups of channels with up to 99 channels in one group. Each group average is computed each time the group is scanned. Averaging functions can be performed at user-selectable time intervals.

Data averages may be printed by the front panel printer or external device. They may also be compared to preset limits in the Alarms Set Point Option (-41).

### Dual Interval Scan Option (-32)

Permits any selected group of inputs to be scanned less frequently than others and as infrequently as 99 hours and 59 minutes.

## Limits and Alarms

### Alarms Set Point Option (-41)

Detects data readings which exceed high or low limits programmed by the user. Contains 60 programmable limit values. Up to 4 may be assigned to any individual channel(s). With Averaging Option -42 installed, limits may be applied to the *average* of a group of channels or to the *time average* of a single channel.

**Alarms-All Mode:** The 2240C may print out only limit data for the channel or channels where a limit has been exceeded. Or, the logger may print all data when and if an alarm condition exists for as long as the condition lasts.

**Alarms-Once Mode:** Prints out-of-limit data once only (in red), and does so again once the channel returns to normal (in black). Or, the logger will print data on all channels once when a channel exceeds a limit and again when the channel returns to normal.

### Alarms Set Point Output Option (-23)

A plug-in circuit card used when it is necessary to provide an electrical output which can control a warning device. An open collector output is provided for each of 30 alarm set points. Two Option -23s are required if you need between 30 and 60 set points (2240C only). The open collector outputs will sink 30 mA maximum. Two 50V, 1A, 15 VA maximum relays are included with each Option -23 that may be controlled by any or all of the open collector transistors. Requires Option -41.

## Output Communications Interfaces

### RS-232-C Interface Options (-12)

All versions of Option -12 have an external TTL-level start-of-scan feature. All except -12B have a maximum output rate of 4800 baud, and all have switch-selectable character deletion.

Option -12M has a male connector compatible with Data Communication Equipment (DCE) or modem type interfaces as defined by EIA Standard RS-232-C.

Option -12L has a female connector compatible with Data Terminal Equipment (DTE).

Option -12B will open or close an external 20 mA current loop when operating with teletype equipment. No current source is provided with Option -12B, however. 300 baud maximum.

### Magnetic Tape Interface Option (-14)

All versions of Option -14 have an external TTL-level start-of-scan feature, switch-selectable character deletion, and a maximum baud rate of 4800.

Option -14G interfaces to the Kennedy 1600/360 and 1610/360 9-track magnetic tape recorders. Recording density is 800 BPI. Data rates to 500 characters per second are achievable and output code is either ASCII or EBCDIC.

## Remote Programmable Interfaces

### IEEE-488 Interface Option (-15)

The data logger may be used as an addressable listener, addressable talker, or in a talk-only mode. It will generate service requests and respond to serial polls. Easily accessible switches lets an operator select the IEEE-488 bus address, talk-only mode, enable service requests, and print one or four readings per line. Cables with standard IEEE-488 connectors are available in 1-meter, 2-meter, and 4-meter lengths but none is supplied as part of Option -15.

### RS-232-C Interface Option (-17)

In addition to outputting scan data, this option responds to serial ASCII characters to control many functions that are normally controlled on the front panel.

This Option provides random access to most channels regardless of what programming or output control is in progress.

Option -17A is compatible with Data Communication Equipment (DCE) or modem type equipment. With it the data logger acts like a terminal.

Option -17B is compatible with DTE or Terminal type equipment.

Option -17C is for TTY type equipment using a 20 mA current loop. This option has transmit and receive current sources available if required.

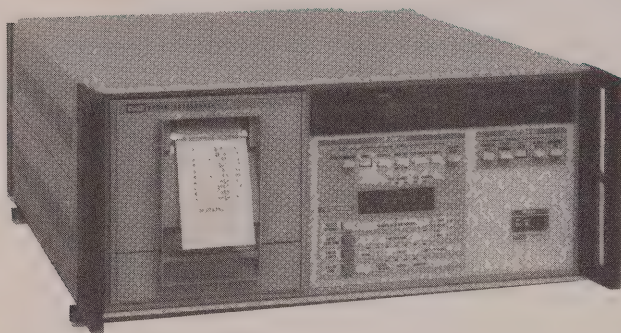
## 2240C Ordering Information

See page 196.



# DATA LOGGERS

## 2200B



2200B

### 2200B Data Logger

- Lowest cost data logger
- Expandable to 100 channels
- Easy to program
- Input and log thermocouples, RTDs, DCV, ACV, dc current, BCD
- Up to 4 user programmed alarms per channel

The 2200B is recommended for comparatively simple data logging operations. It will scan up to 60 input channels as a stand-alone instrument and up to 100 channels if connected to a 2201A, 2202A, or 2203A Scanner Extender. Included in the price of each 2200B is a 10-channel scanner card option (-06) and a mating connector option (-08) that will handle either dc voltage or thermocouple inputs. Also included is an A-to-D converter circuit card and the capability to linearize up to four different combinations of RTDs, current transmitter inputs, and/or thermocouple types (from a list of 15).

The LED display panel indicates volts, millivolts, temperature, and channel number. A 16-column printer is built into the 2200B for recording measurement data or making a hard copy of each test set-up (measurement program). The fanfold paper is 2¼ inches (5.7 cm) wide. Up to 2.5 lines per second may be printed.

No computer programming experience is required to operate any Fluke Data Logger. Pushbuttons and digital thumbwheels on the front panel of the 2200B are grouped and labeled to make operation and programming easy. Scanning may be programmed to be periodic at selected time intervals, continuous, or triggered manually or remotely. The printer may be programmed to record all data from each scan or only data that is outside preselected limits for any channel.

### Specifications

**Mainframes:** One 2200B per system, plus one Scanner Extender if more than 60 channels must be scanned

**Maximum Inputs:** ≤100 per system

**Maximum Analog Inputs:** ≤100 per system

**Maximum BCD Inputs:** Three 9-digit BCD numbers

**Status Outputs:** ≤10 per system

**Alarm Outputs:** ≤2 relay outputs plus any of the status outputs

**Computation Power:** Capability of measuring and linearizing four thermocouples, RTDs, and current transmitters. The readout is switch-selectable in °C or °F. Four linearizations may be chosen from: NBS linearizations for thermocouple types J,K,T,E,R,S, and B; DIN linearizations for types J,K,T, and S; industry linearizations for types C, G, and D, and JIS type R (PR-19). When using RTD inputs, linearizations for 100Ω platinum 385 or 392 and 10Ω copper are choices. When using current transmitter inputs, Option -28, -29, or -30 is needed and the readout may be scaled 0 to 100%

**Distance Between Mainframes:** ≤50 feet to 2201A; 6-foot cable standard with 2201A

#### 2200B Mainframe

**Capacity:** Six slots for input options. One -06 with -08 is supplied

**Scanning Speed:** ≤15 channels per second

**Internal Printer:** A 16-column impact printer for fan-fold 5.7 cm (2¼-in) paper. Prints up to 2.5 lines per second, each successive line above the other. For recording program steps as well as logging data

**Program Memory:** Sufficient for 100 channels. Non-volatile

**Temperature:** 0°C to 50°C, operating; -40°C to 60°C, non-operating

**Relative Humidity:** ≤80%, non-condensing, to 35°C; ≤70%, non-condensing, to 50°C

**Shock and Vibration:** Meets requirements of MIL-T-28800C

**Power:** 100, 115, or 230V ac ±10%, 50 or 60 Hz; less than 50W, maximum. Internal switches for 115 or 230V ac operation

**Size:** 15.4 cm H x 37.5 cm W x 49.5 cm L (7 in x 17 in x 22.5 in)

**Weight:** Approximately 18 kg (40 lb), depending on options

#### 2201A Scanner Extender

**Capacity:** 12 slots for scanner cards. 2201A only needed if more than six scanner cards (60 channels) are required

**Power:** Supplied by 2200B

#### High Performance A/D Converter

Each 2200B includes an analog-to-digital converter. It is a plug-in circuit that measures and digitizes all analog data from the input scanner(s)

**Measurement Speed:** 3 or 15 readings per second, switch-selectable

**Dynamic Range:** 40,000 counts

**Ranges:** ±40 mV, ±400 mV, ±4V, and ±40V

**Resolution:** 1 μV on 40 mV range

**Common Mode Noise Rejection:** ≥140 dB at 50 and 60 Hz ±0.1%, ≥120 dB at dc, with 1 kΩ unbalance, at slow speed. At high speed the same except 110 dB at 50 and 60 Hz

**Common Mode Voltage:** ±170V dc or peak ac, system max

**Normal Mode Noise Rejection:** ≥70 dB at 50 or 60 Hz ±0.1%, at slow speed. At high speed ≥55 dB

**Reference Voltages:** 2V and 0.02V at jacks in rear

**Reference Voltage Accuracy:** ±0.02% for 90 days from 20°C to 30°C

### 2200B Input Options

For These Inputs	Use Connector Option	With Scanner Option	Maximum Inputs per Scanner
Thermocouples & Low DC Voltage	-08*	-06*	10
Low DC Voltage	-07 or -08	-06	10
DC Voltage	-07 or -08	-05 or -06	10
AC Voltage	-07 or -08	-33/AL	8
1-5 mA DC	-28	-05 or -06	10
4-20 mA DC	-29	-05 or -06	10
10-50 mA DC	-30	-05 or -06	10
RTDs	-03	-33	8
BCD Digits	None	-16	9

\*One included with each 2200B

### Voltage and Thermocouple Inputs

#### Low Level Scanner Option (-06)

One option included with 2200B. Ten channels per option. Ten 3-wire dry reed relays (Hi, Lo, shield).

**Life:** Rated for >10<sup>8</sup> operations with ≤50V ac rms applied;

**Thermal Offset:** <1 μV per channel

**Maximum Voltage:** 170V dc or peak ac between any input terminal and system ground or other terminal

#### General Purpose Scanner Option (-05)

Please refer to page 191.

#### Solder Pin Connector Option (-07)

Please refer to page 191.

**DC Voltage Accuracy**

Same as for 2240C. Please refer to page 191.

**Isothermal Connector Option (-08)**

One included with each 2200B. A card-edge connector assembly designed for use in making thermocouple temperature measurements and/or low level voltage measurements. Intended to be plugged onto Scanner Option -06. Ten 3-wire sets of screw terminals. The maximum temperature gradient between any two terminals or the isothermal block (reference junction) is  $\pm 0.05^{\circ}\text{C}$ . Any combination of dc voltage and/or thermocouple type can be assigned as inputs.

**Temperature Measurement Accuracy, Thermocouples**

Same as for 2240C. Please refer to page 191.

**DC Current Inputs****Current Connector Options (-28, -29, -30)**

Current is measured using a voltage input scanner and attaching one of three current input connector options, depending on the current range: 1 to 5 mA, 4 to 20 mA, or 10 to 50 mA. Voltage is sensed by passing the input currents through separate precision resistors and measuring the voltage-drop across each resistor.

Option -28 is for 1 to 5 mA current transmitters. Shunt resistors: 60 $\Omega$ .

Option -29 is for 4 to 20 mA current transmitters. Shunt resistors: 15 $\Omega$ .

Option -30 is for 10 to 50 mA current transmitters. Shunt resistors: 6 $\Omega$ .

**Current Measurement Accuracy:** Same as for dc voltage measurements plus ( $\pm 0.1\%$  of reading)

**RTD Inputs****RTD Scanner Option (-33)**

Eight channels per option. Four-wire configurations plus one guard wire common to all channels. Switched current source excites RTD being scanned. Separate calibration and adjustment for each channel. Linearization for 100 $\Omega$  platinum.

For more specifications please refer to page 192.

**RTD Connector Option (-03)**

A card-edge connector assembly which plugs onto an RTD Scanner Option. Four screw-terminals for each input channel for 4-wire RTDs. Terminals are HI, LO, S+, and S1-.

**Temperature Measurement Accuracy, RTDs\***

Temperature Range with 100 $\Omega$ Platinum RTD	Maximum Instrument Error ( $\pm^{\circ}\text{C}$ )		
	90 Days 20 $^{\circ}\text{C}$ to 30 $^{\circ}\text{C}$		1 Year 15 $^{\circ}\text{C}$ to 25 $^{\circ}\text{C}$
	Rdgs/Sec 2.5	15	Rdgs/Sec 2.5
-200 $^{\circ}\text{C}$ to +450 $^{\circ}\text{C}$	0.3 $^{\circ}\text{C}$	0.4 $^{\circ}\text{C}$	0.4 $^{\circ}\text{C}$
+450 $^{\circ}\text{C}$ to +800 $^{\circ}\text{C}$	0.4 $^{\circ}\text{C}$	0.5 $^{\circ}\text{C}$	0.5 $^{\circ}\text{C}$

\*Total Instrument Accuracy, using Option -03 and -33.

**BCD Inputs****Digital Input Option (-16)**

This circuit card accepts up to nine digits of BCD input data for display as supplementary heading data.

**Other 2200B Options**

Option	Description	Used With	
		2200B	2240C
Temperature Linearizations			
-11*	Thermocouples, RTDs, Current	Yes	No
Scaling & Conditioning			
-26	mX+b Scaling	Yes	No
-27	Engineering Units Notation	Yes	No
Limits and Alarms			
-34	Alarms Setpoints	Yes	No
-23	Alarms Outputs	Yes	Yes
Communications Interfaces			
-12	RS-232-C (Output)	Yes	Yes
-14	Magnetic Tape (Output)	Yes	Yes
-37	IEEE-488 (Output)	Yes	No

\*Included with each 2200B

**Scaling and Conditioning****Multiple-Scaling Option (-26)**

Provides up to four mx+b scaling functions of any signal. These must be specified at order time and are not changeable from the front panel. Ask for Temperature and Scaling Worksheet.

**Engineering Units Notation Option (-27)**

Allows selected voltage ranges, decimal point positioning, and engineering units to be assigned as scales for up to four functions. For example, if a pressure transducer provides a 0 to 100 mV output for a 0 to 1000 psi input, a direct readout and printout of 1000 psi can be made by shifting the decimal point and addressing different print wheel combinations on the printer. This example assumes a linear scale. Ask for Temperature and Scaling Worksheet.

**Limits and Alarms****Alarms Set Point Option (-34)**

Detects when readout crosses high and/or low limits programmed by the user. Up to four limits may be assigned to any channel or channels. Up to 40 may be selected for each 2200B.

**Alarms Set Point Output Option (-23)**

Used when it is necessary to provide an electrical output when a limit has been crossed. Ten open-collector outputs are provided. Two 50-volt, 1-ampere relays are included that may be controlled by any of the open-collector outputs. Requires Option -34.

**Output Communications Interfaces**

Four RS-232-C Interface Options are available (-12) as well as for magnetic tape recorders (-14). For more information please see page 193.

**IEEE-488 Interface Option (-37)**

Switch-selectable operation either as an addressable talker, using an instrument controller, or for the talk-only mode. May be remotely triggered to scan. Field-installable.

**2240C & 2200B Accessory Descriptions**

**2200A-7001:** Remote Scanner Cable Connector and assembly. A required part of connecting cable assembly for Model 2202A Scanner Chassis.

**2200A-7002:** Remote Scanner Chassis Cable. Length must be specified. A required part of connecting cable assembly for Model 2202A Scanner Chassis. Priced by the foot. Requires -7001 above.

**2200A-7003:** Standard Scanner Adapter. One required for each Option -05 or -06 Scanner circuit card installed in Model 2203A RTD Scanner Chassis.

**2200A-7005:** Extender Cables. A set of two extender cables for servicing vertical plug-in pcb's.



# DATA LOGGERS

## 2200B

**2200A-7006:** General Purpose Interface Cable. Six foot, 50-wire cable with 50-pin connector installed on one end. For Option -16 and Option -23.

**2010A-7013:** Fan-fold printer paper. A package of twelve packets of paper for the data logger's front panel printer.

**2010A-7014:** Printer Ribbon. A package of twelve spools of two-color (red and black) ribbons for the data logger's front panel printer.

**M07-205-600:** 7-inch Rack Adapter. For 2200B or 2240C Data Logger or 2201A, 2202A, or 2203A Extender Chassis.

**M00-260-610:** 18-inch rack slides and hardware.

**M00-280-610:** 24-inch rack slides and mounting hardware.

**A22-6:** Roll Paper Adapter. Adapts 2200B or 2240C front panel printer to use standard adding machine roll paper.

### Models

January 1985 prices

2280B Data Logging System .....	\$6995
2285B Data Logger .....	4995
2281A Extender Chassis .....	800
2240C Data Logger .....	5995
2200B Data Logger, w/-06 and -08 .....	3995
2201A Scanner Extender Chassis .....	1495
2202A Remote Scanner Chassis .....	1795
2203A RTD Scanner Chassis .....	2295

### 2280 SERIES Options

2280A-160 AC & DC Input Connector .....	275
2280A-161 High Performance A/D Converter .....	800
2280A-162 Thermocouple & DC Scanner .....	625
2280A-163 RTD & Ohms Scanner .....	995
2280A-164 RTD, Ohms, Strain Excitation .....	620
2280B-167 Counter/Totalizer .....	900
2280A-167/AA Counter/Totalizer .....	on req.
2280A-168 Digital or Status Input/Output .....	700
2280A-169 Status Output Connector .....	100
2280A-170 Analog Output .....	995
2280A-171 Current Input Connector .....	200
2280A-174 Transducer Excitation Connector .....	375
2280A-175 Isothermal Input Connector .....	175
2280A-176 DC Voltage Input Connector .....	100
2280A-177 RTD, Ohms Connector .....	200
2280A-179 Digital/Status Input Connector .....	100
2280A-211* Advanced Math .....	1200
2280A-214* DC 100 Tape Drive Unit .....	1900
2280A-341 RS-232 Interface .....	990
2280A-342 IEEE-488 Interface .....	990
2281A-402 Connecting Cable (per meter) .....	4
2281A-403 Connectors for Option -402 .....	95
2281A-431 Power Supply for 2281A .....	495

\*Factory or Service Center installation only. Others user-installable

### 2280A SERIES Accessories (Also see page 230)

Y2042 Pack of 5 DC 100 Cassettes .....	130
Y2044 Rack Slide Kit .....	195
Y2045 Rack Mount Kit .....	120
Y2046 Pack of 10 Rolls Printer Paper .....	50
A22-300 Transit Case for 2280A .....	on req.
A22-301 Tape Reader for DC 100 Tapes .....	on req.

### 2240C & 2200B Options

2200A-03 RTD Connector .....	105
2200A-04 RTD Scanner .....	495
2200A-05 General Purpose Scanner .....	270
2200A-06 Low Level Scanner .....	325
2200A-07 Solder Pin Connector .....	55
2200A-08 Isothermal Block Connector .....	130
2200A-12B Interface for ASR33 .....	1145
2200A-12M Interface to RS-232-C Modems .....	1145
2200A-14G Interface for Kennedy 1600/360, 1610/360 .....	1210
2240B-15 IEEE Interface .....	1320
2200A-16 Digital Input (BCD) .....	465
2240B-17A Remote Control, RS-232-C, Modem .....	1195
2240B-17B Remote Control, RS-232-C, Terminal .....	1195
2240B-17C Remote Control, 20 mA Loop, TTY .....	1195
2240A-23 Alarm Set Point Outputs .....	399
2240B-26* Multiple Scaling .....	440
2240A-27* Engineering Units Notation .....	165
2240A-28 Connector for 1 to 5 mA Transmitters .....	210
2240A-29 Connector for 4 to 20 mA Transmitters .....	210
2240A-30 Connector for 10 to 50 mA Transmitters .....	210
2240B-32* Dual Interval Scan .....	360
2240A-33 Interchangeable RTD Scanner .....	455
2240A-33/AL AC Voltage Scanner .....	on req.
2200B-34* 40 Alarm Limit Set Points .....	760
2200B-37 IEEE Interface .....	1380
2240C-40* mx+b Scaling .....	178
2240C-41* Alarm Set Point .....	345
2240C-42* Time and Group Average .....	180
2240C-43* Temperature Scaling Group One .....	290
2240C-44* Temperature Scaling Group Two .....	290
2240C-45* Temperature Scaling Group Three .....	290

### 2240C & 2200B Accessories (Also see page 230)

2200A-7001 Cable Connector & Assembly .....	165
2200A-7002 Remote Scanner Cable (per foot) .....	5
2200A-7003 RTD-to-Standard Scanner Adapter .....	58
2200A-7005 Extender Cable .....	250
2200A-7006 Digital Input/Alarm Output Cable .....	180
2200A-12/AG Remote Start .....	on req.
2200A-16/AA Battery Backed-Up Clock .....	on req.
2010A-7013 Fan-fold Printer Paper (12 packets) .....	35
2010A-7014 Printer Ribbon (12 spools) .....	35
2240A/ACK Crystal Oscillator .....	on req.
M00-260-610 18" Rack Slides .....	105
M00-280-610 24" Rack Slides .....	110
M07-205-600 7" Rack Adapter .....	100
A22-6 Printer Roll Paper Adapter .....	on req.
A22-148 Tandberg BDL-3000 Cartridge Recorder (RS-232-C) .....	on req.
A22-150 Tandberg GPIB-3000 Cartridge Recorder (IEEE-488) .....	on req.

\*Factory or Service Center installation only. Others user-installable

### After-Warranty Service (See page 227)

SC1-2280B, per 90-day interval .....	700
SC1-2281A, per 90-day interval .....	348
SC1-2240C, per 90-day interval .....	808
SC1-2200B, per 90-day interval .....	460
SC1-2201A, per 90-day interval .....	220
SC1-2202A, per 90-day interval .....	356
SC1-2203A, per 90-day interval .....	448

### On-Site Service Agreement

Available for 2280B and 2281A.

# MEASUREMENT & CONTROL PRODUCTS

## Introduction

Accuracy in measurement and control systems is more important today than ever before. Small changes in process or test parameters often mean the difference between good and marginal product, profit and loss. Fluke recognized this when we developed our 2400B Intelligent Computer Front End. (See the other side of this page for a discussion of an Intelligent Front End.)

The 2400B is the keystone to a highly accurate and versatile measurement and control system. Bridging the gap between the real world and your computer, it features a wide range of analog and digital input and output options. You configure the modular 2400B to meet your application.

The 2400B can be used with a host computer or in a stand alone configuration. The intelligence of the 2400B means that raw data from input sensors is linearized, scaled, or otherwise manipulated before being sent on to the host. Your host computer can thus spend its time handling file manipulation or data storage, tasks to which it is well suited. In fact, the 2400B will continue to monitor inputs, make decisions, and output changes all by itself.

You program the 2400B using the Fluke Measurement and Control language. Optimized for measurement and control, the 2400B's language is BASIC-like. Its structured format makes the application program you develop easy to follow.

When the 2400B is combined with a Fluke 1722A Instrument Controller, the result is an integrated 2452MCS Measurement and Control System. The 2452MCS features a unique touch-sensitive screen for a friendly operator interface. Development software is also included to get you up and running quickly. You can be taking data and controlling outputs in a very short while. Additional application software packages are available as well.

## Selection Guide

Inputs:	2400B	2452MCS	2280B
Thermocouples	X	X	X
DC Volts	X	X	X
AC Volts	X	X	X
Current	X	X	X
Ohms	X	X	X
RTD	X	X	X
Transducers	X	X	X
Strain Gages	X	X	X
BCD	X	X	X
Binary	X	X	X
Status	X	X	X
Counter	X	X	X
Totalize	X	X	X
Interrupts	X	X	—
Sequence of Events	X	X	—
Outputs:			
Status (Digital)	X	X	X
Relay	X	X	—
DC Volts	X	X	X
Current	X	X	X
Resistance	X	X	—
Stepper Motor Controller	X	X	—
Features:			
RS-232-C Interface	X	X	X
RS-422 Interface	X	X	—
IEEE-488 Interface	X	X	X
Current Loop Interface	X	X	X
Touch Sensitive Display	—	X	—
Graphics	—	X	—
Language Programmable	X	X	—
Floppy Disk	—	X	—
Mass Storage	—	X	X
Menu Programmable	—	—	X
Printer/Plotter	—	—	X
12V DC Powered	—	—	X
Multiple A/Ds	No	No	Yes
Maximum No. Channels Per Mainframe	60	60	100
Maximum No. Channels Per System	*	*	1500 Total

\* Depends on option type. For example, 1000 analog inputs plus 1024 status (digital) inputs plus 1024 status (digital) outputs



## What Is An "Intelligent" Computer Front End?

Computer front ends come in two varieties "dumb" and "intelligent." What is the difference between the two, and why is it important to you?

All computer front ends translate the (mostly) analog signals of the real world into numbers that your computer can understand. A dumb front end does little more than this. The data that it sends may have to be scaled, linearized, or otherwise manipulated by your host computer. You, the user, must write the software to transform these raw readings into something useful.

Intelligent computer front ends, in contrast, process the data before sending it on to the host. For example, data from thermocouple inputs are sent in degrees, rather than compensated millivolts.

The 2400B does much more than this, however. Its intelligence separates it from the rest of the intelligent computer front ends.

## Runs Independently

The 2400B can operate in a stand-alone application. Many other front ends claim this capability, but they generally refer to their ability to be run from programs stored in EPROM. The 2400B, too, can operate this way.

However, the 2400B can also have its program downloaded from the host computer. The host can then be physically disconnected from the 2400B. The stored program will continue to operate independently of the host.

Why is this important? First, it can save you money because you do not need to have a host for each front end.

Second, even if you choose to have a host computer attached to your front end, the front end will not take much of your host's attention. This translates directly to less dollars of mainframe time, or more availability of a personal computer's time to do other things for you besides take data.

## Two Simultaneous Modes

The 2400B's intelligence also allows it to function in two modes: stored program and immediate. With the stored program mode, the 2400B follows a game plan that you write. In the immediate mode, you can change the values of program constants, or interrogate the 2400B for the values of variables or inputs.

The immediate mode allows you to tune a loop, change a limit or setpoint, all in real time while your application program is running. There's no need to stop the process or test, reset a variable, and download the program again. This means less programming effort.

## Easier Programming

Many of the 2400B Measurement and Control Language (MCL) features are designed to make programming your custom application easier.

Procedures allow you to perform your frequently used routines with a single word, saving you programming time and money.

Postfunctions automatically scale your transducer inputs. You simply define a postfunction once and the channels to which it applies. All references to those channels will be automatically scaled, without further software effort on your part.

The SCAN command allows you to input readings from a range of channels and store the data into arrays. The scan can execute concurrently with other stored program statements. So, your stored program can perform limit checking or data manipulation, output this data to your host, all at the same time you input readings from the 2400B.

All in all, the intelligence of the 2400B makes the job of solving your application much easier.

## Serial Interface Message Protocols: What are they and why are they useful?

For those of our customers who intend on talking to their host computers using RS-232-C, RS-422, or 20 mA current loop interfaces, Fluke supports five message transfer protocols.

### Serial Interface Protocols

1. Simple Terminal
2. Simple Terminal with Flow Control (XON, XOFF)
3. Simple Terminal with Flow Control and Timeout
4. Blocked Format with Acknowledgements
5. Blocked Format with Acknowledgements and Check Character

Protocols are "rules" for communicating data between two devices. Most host computers implement one type or another automatically. This is especially true of the simple terminal protocols.

However, you might choose to implement one of the blocked format protocols if your environment is electrically noisy, or if you had to ensure the integrity of your data.

What exactly are these message protocols?

Consider communications between two devices, A and B. In the simplest case, A talks to B, and B talks to A. This corresponds to a simple terminal protocol.

What if A sends data faster than B can receive it? Unless B has a way of signalling A to stop sending for awhile, data will be lost. The simple terminal with flow control lets B tell A to stop sending until signalled to start again.

Suppose, however, that A never heard B's request to start sending data again. Communications would be halted forever. The simple terminal with flow control and timeout protocol handles this situation. Device B would wait a specified amount of time with no input, and would again ask device A to start sending.

These first three protocols work well at any speed in reliable transmission environments. However, what happens if an error occurs during transmission? Device B has no way to tell A to retransmit the message.

The last two protocols have built-in error detection and recovery procedures, however. Using the blocked format with acknowledgements protocol, device B could tell A that an error occurred. Device A would retransmit the message. The important point is that A will not transmit a new message until device B has positively acknowledged the last one.

The fourth protocol will detect most transmission errors. But, if two or any even number of data bits in a character get inverted due to noise, the error will not be detected because the character parity has not changed.

The last protocol, blocked format with acknowledgements and check character, eliminates this possibility. This is because a parity check character is calculated for the entire message. Devices A and B each separately calculate their own check characters. If the two do not match, the message is sent again.

The two blocked format protocols are designed to help the 2400B communicate with its host in an electrically noisy environment. Fluke can provide you with information to help you implement this highest level protocol if your application requires it. Contact your local Fluke sales office.

# MEASUREMENT & CONTROL PRODUCTS

## 2452MCS Measurement & Control System



2452MCS

### 2452MCS Measurement & Control System

- Complete system — combines 2400B Intelligent Computer Front End, 1722A Instrument Controller, and software
- Extensive selection of I/O options — expandable to over 1000 channels with 2401A and 2402A extender chassis
- Touch sensitive screen — friendly operator interface with graphics
- "Multi-computing" — 2400B handles scanning, linearizations, limit checking and direct control of test or process. — 1722A downloads and modifies 2400B program, retrieves scanned data, formats and outputs reports, and provides operator interface
- Available with or without 28 inch cabinet
- Choice of IEEE-488 or Serial (RS-232-C, RS-422, current loop) Interfaces

The 2452MCS is a fully integrated measurement and control system which combines the power of two intelligent Fluke instruments — the 1722A Instrument Controller and the 2400B Intelligent Computer Front End. The system is housed in a locking cabinet that fits on either a work bench or separate stand and includes all the hardware, cables, drawers, etc. necessary to combine the 2400B and 1722A into a complete measurement and control system. Alternatively, the 2452MCS may be ordered without a cabinet to be mounted in your own rack or panel.

The 2400B provides digital and analog measurement, signal conditioning, control outputs, and intelligent decision making, while the 1722A provides tremendous computing power, a CRT display with a touch-sensitive overlay, advanced graphics capabilities, and mass storage via a double-sided floppy disk. Both instruments work together, sometimes independently, sometimes cooperatively, providing a multi-computing system with the power and flexibility to expand as your application requirements increase.

The programmer's keyboard is placed on a convenient sliding rack drawer that may be locked to prevent unauthorized program modification. The system can be programmed to allow the touch-sensitive CRT display to be the operator's interface. This reduces operator errors and training time because the operator interacts with a friendly CRT display customized for the application and written in familiar words.

The 2452MCS, when equipped with the 2400B's Serial interface, permits the 2400B to be located up to 1220 meters (4000 feet) away from the 1722A. A distributed data acquisition system may be constructed in this manner using a single 1722A and multiple 2400Bs, in either star or "daisy chain" configurations.

The basic 2452MCS System includes the software tools, and hardware necessary to make it operate as a ten-channel data acquisition system. The system is expandable to sixty channels in the basic 2400B mainframe and to over 1000 channels by adding 2401A and/or 2402A Extender Chassis and input/output options.

### Input/Output Capabilities

The measurement of analog inputs such as thermocouples, RTDs, strain gages, dc and ac voltages, and currents is performed by a 17-bit A/D converter. Capable of resolving  $1\mu\text{V}$ , the highly accurate A/D conversion preserves data integrity through a sophisticated noise rejection technique that synchronizes its measurement period with the power line frequency.

Digital inputs accommodated by the 2452MCS include status, contact closure, interrupt, BCD, pulse, frequency, totalizing and sequence of events.

Controlling outputs sourced by the 2452MCS consist of voltage, 4-20 mA current, resistance, stepper motor control, TTL outputs, and relay closures. A complete description of input/output capabilities is found in the pages describing the 2400B.

Software supplied with the system includes a program development package ("ProLink II"), an enhanced BASIC interpreter with extended graphics capabilities, an advanced Editor, and a File Utility Program. The 2452MCS -03 and -04 also include the ProComm software package. (ProLink II and ProComm are both described in a section immediately following the 2452MCS description.) This complete package makes it easy for an individual with some knowledge of BASIC or other high-level programming language to create a custom-tailored data acquisition program to meet any application.

If you want to "come up to speed" and write your application program in a hurry, Fluke can help — with training classes held either at our head offices in Everett, Washington, U.S.A., or at your site. We can also arrange for one of our in-house experts to assist you personally in creating your application-solving software through a program called "Systems Lab."

If a turn-key system is what you require, Fluke has an extensive list of recommended software consultants that are experienced with Fluke equipment and capable of fulfilling your needs. The Fluke Customer Support Group is also available to write custom application software and combine with Fluke hardware for a complete system. Information on training classes, Systems Lab, software consultants, and the Customer Support Group is available from your Fluke Sales Engineer or Representative.



# MEASUREMENT & CONTROL PRODUCTS

## 2452MCS Measurement & Control System

### Specifications

For complete specifications please refer to the pages in this catalog describing the 1722A and the following pages that describe the 2400B.

**CRT Display:** High contrast green phosphor, high resolution, 5x9 inch display screen. Sixteen lines of eighty characters or eight lines of forty characters, selectable by program control.

**Transparent Touch-Sensitive Overlay:** Positioned directly over the display screen. Provides a 6x10 array of touch-sense areas for dynamic operator interface.

**Graphics Display:** 640 by 224 dots, hardware sector generator

**Memory, 1722A:** 136K bytes of RAM (expandable to over 2.6M bytes)

**Memory, 2400B:** 28K bytes of RAM for program storage

**Mass Storage**

- Double-sided 5¼-inch floppy disk stores 400K bytes
- 800K bytes more with dual floppy disk drive (optional)
- 10M bytes with Winchester Disk (optional)
- 1.3M-byte bubble memory (optional)

**1722A Interfaces:** One IEEE-488 port and one RS-232-C port is standard. May be expanded to include six additional RS-232-C, RS-422, and/or 20 mA serial ports or a second IEEE-488 port

**2400B Interfaces:** Three. One IEEE-488 port or one serial (RS-232-C, RS-422, or 20 mA) port, and two RS-232-C output-only ports

**Temperature:** 10°C to 30°C, operating; -10°C to 60°C, non-operating (except floppy disks limited to 10°C to 52°C)

**Relative Humidity:** 5% to 80% operating, non-condensing; 5% to 95%, non-operating and non-condensing (except floppy disks limited to 8% to 90%)

**Power:** 90 to 132V ac or 180 to 264V ac, switch-selectable, 50 Hz to 60 Hz,  $\pm 2$  Hz

**Size:** 70.6 cm H x 61.0 cm W x 70.5 cm D (27.8 in x 24 in x 27.8 in)

**Weight:** 84 kg (185 lb) approximately, not including options

### Models

January 1985 prices

2452MCS-01	\$14,990
2452MCS-02	14,550
2452MCS-03	14,990
2452MCS-04	14,550

Model and Version	Rack Cabinet 71 cm (28 in) High	2400B Interface and 2 Meter Cable
2452MCS-01	Yes	IEEE-488 (Opt -002)
2452MCS-02	No	IEEE-488 (Opt -002)
2452MCS-03	Yes	Serial (Opt -001)
2452MCS-04	No	Serial (Opt -001)

The rack cabinet has a lockable storage drawer and keyboard drawer, a rear door, and associated hardware.

Also included are:

- 1722A with Keyboard
- Fluke enhanced BASIC Interpreter, Advanced Editor, File Utility Program
- ProLink II application software package (see page following for description)
- ProComm application software package (-03, -04 only) (see page following for description)
- 2400B with Option -101, -102, -109, and -002 (or -001)
- Integral power strip and power cord
- Full set of Operator and Service Manuals
- 90-day on-site service

### Options

See 2400B and 1722A pages

### Accessories (Also see page 230)

A24-89 71 cm Instrument Rack (28 in)	on req.
A24-75 183 cm Instrument Rack (6 ft)	on req.
A24-90 Wheeled based, for A24-89 or A24-75	on req.
A24-123 Serial Impact Printer w/RS-232-C I/F	on req.
Y2055 15-Pin Multi-Connector for Multi-Drop	95
RS-422 Hook-up ("Y" Connector)	
1765A/AB 10M-byte Winchester Disk Drive	4250
1761A External Disk Drive, 2x400K bytes	2950
1760A External Disk Drive, 400K bytes	1950

### After-Warranty Service (See page 227)

SC1-2452MCS, per 90-day interval	1500
On-Site Service Agreement available	

# MEASUREMENT & CONTROL PRODUCTS

## Measurement & Control Software

### Measurement & Control Software

For the first time, Fluke offers a wide range of application software to help you develop your 2400B program.

Three of these software packages are designed to be used with the 2452MCS. They are Fluke ProLink II<sup>(TM)</sup> Application Software, ProComm<sup>(TM)</sup> Serial Communications Utility Package, and ProGen<sup>(TM)</sup> Application Software Package.

A fourth software development tool, ProLink PC<sup>(TM)</sup>, runs on your IBM PC<sup>(TM)</sup>, PC XT<sup>(TM)</sup>, or IBM look-alike.

#### ProLink II Application Software

- For use with Fluke 1722A and 2400B — ProLink II is supplied with all 2452MCS Systems
- Simplifies development of 2400B application program
- Menu-driven user interface

Fluke ProLink II Application Software comes standard with all 2452MCS systems. It is a tool which makes developing 2452MCS application program easier.

The 2452MCS consists of two independent computers: the Fluke 2400B and the 1722A Instrument Controller. These two computers must talk to each other in order to do the job. Fluke ProLink II handles a lot of the system housekeeping tasks you would otherwise have to do. It presents you with a single user interface to both the 1722A and 2400B.

ProLink II presents the user with a menu of choices. You simply move the cursor to the proper selection and press the carriage return. This "one-touch" approach lets you do the following:

1. Automatically run Fluke BASIC; FUP, the File Utility Program which allows you to copy, move, delete or otherwise manipulate files; and SET, which allows you to set the RS-232-C characteristics of the 1722A Instrument Controller's output ports. After exiting any of these three programs, you will automatically be returned to ProLink II.
2. Automatically send bus commands to the 2400B and display responses to those commands.
3. Automatically display English language error messages if an error occurs.
4. Select, edit, download or retrieve user written 2400B programs.
5. Monitor selected variables during program execution. This function is very useful during the program debugging stage. You can download and run your 2400B program, and then monitor certain key variables. In this way you can ensure that variables are changing as you expect them to.
6. Print a hard copy of a file on an external printer.

#### ProComm Serial Communications Utility Package

- For use with 1722A and 2400B equipped with 2400B-001 serial I/F — supplied standard with 2452MCS-03 and -04
- Implements serial communications between 1722A and 2400B, or multiple 2400Bs connected to single 1722A
- Provides built-in error detection and recovery capability
- Supports communications via modems as well as "hard-wired"

ProComm<sup>(TM)</sup> Serial Communications Utility Package comes standard with both serial versions of the 2452MCS, -03 and -04.

ProComm software is a utility package which implements serial communications between the 1722A Instrument Controller and the 2400B Front End. The subroutines are callable from BASIC.

There are three functions which ProComm software can provide for you. If you are using an RS-422 or current loop transmission line, you

can have more than one 2400B connected to your 1722A. This is called a multipoint system. ProComm software allows you to address and unaddress (terminate communications with) each 2400B in your system.

Second, ProComm software also implements the highest level message transfer protocol supported by the 2400B, blocked format with acknowledgements and check character. This message transmission protocol provides your communications link with built-in error detection and recovery capability. It is especially useful in electrically noisy applications, or where you must guarantee the integrity of your data.

Third, if you are using a 2400B with an autoanswer modem across an RS-232-C interface, ProComm software will automatically hang up the phone line on demand.

#### ProGen Application Software

- For use with 2452MCS Systems
- Menu-prompted monitoring/controlling/logging program
- Requires no language programming knowledge to operate
- Supports up to 500 channels of input/output

ProGen Application Software allows user to get up and running quickly with the 2452MCS. It is a menu-prompted tool which actually programs the 2452MCS for you. Your 2452MCS can be monitoring and controlling your process or test in a short time.

ProGen software is compatible with all versions of 2452MCS, serial or IEEE-488. A 17XXA-007 512K byte RAM expansion option must be installed.

Fluke realizes that there may be one person who programs the application, and another who operates it. Accordingly, ProGen software has two separate disks: Programmer and Operator.

The person responsible for configuring the 2452MCS to meet the application uses the Programmer disk. This disk, in turn, creates the Operator disk.

The programmer is prompted to either "fill-in-the-blanks" or use the cursor control keys to move the cursor to the proper choice. Up to 500 channels can be monitored and controlled. In addition, you may select one of up to 100 user-defined limits lists of four limits each to apply to each channel.

The operator can change only those limits and setpoints which the programmer allows. The operator can, however, choose to monitor all data, some data, or alarms only. Alarm data is automatically recorded.

ProGen software is the easy way to get your 2452MCS up and running.

#### ProLink PC Application Software

- For use with IBM PC<sup>(TM)</sup> and Fluke 2400B Intelligent Computer Front End (serial communication)
- Simplifies development of 2400B measurement and control program
- Menu-driven user interface

ProLink PC is a menu-driven tool for developing 2400B programs with an IBM PC<sup>(TM)</sup>, PC XT<sup>(TM)</sup>, or IBM look-alike. Similar in scope and function to ProLink II software, ProLink PC software will handle the communications between the two computers.

Your IBM PC must have an optional serial interface installed. Since the PC XT has this interface standard, ProLink PC software will operate directly on the XT. MS-DOS<sup>(TM)</sup> version 2.1 or higher is required.



# MEASUREMENT & CONTROL PRODUCTS

## Measurement & Control Software

The operator interface operates similar to ProLink II. The user is presented with a menu of choices. These choices allow you to do the following:

1. Set the RS-232-C characteristics of the IBM communications ports.
2. Select, download, or retrieve user written 2400B programs.
3. Automatically send bus commands to the 2400B and display responses to those commands.
4. Automatically display English language error messages if an error occurs.
5. Monitor selected variables during program execution for program debugging.
6. Print a hard copy of a file on an external printer.

7. Exit ProLink PC to the IBM's operating system. The user can then use the editor EDLIN to edit his 2400B program.
8. Automatically set the date and time in the 2400B.

*\*IBM PC and IBM PC XT are trademarks of International Business Machines, Inc.*

*\*MS-DOS is a trademark of MicroSoft, Inc.*

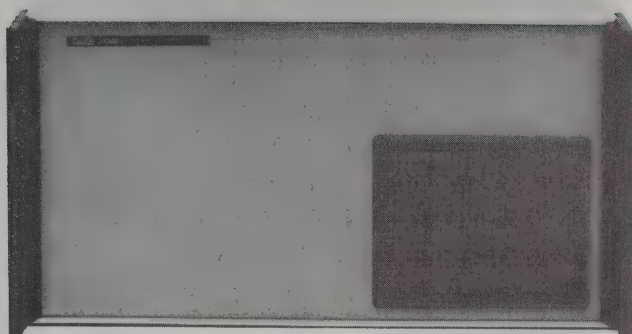
### Models

January 1985 prices

<b>S2400</b> ProLink II Application Software .....	\$ 795
<b>S2417</b> ProComm Serial Communications Package .....	295
<b>S2452</b> ProGen Application Software .....	2990
<b>S2401</b> ProLink PC Application Software .....	450

# MEASUREMENT & CONTROL PRODUCTS

## 2400B Intelligent Computer Front End



2400B

### 2400B Intelligent Computer Front End

- Handles nearly any I/O requirement with an extensive selection of options
- Modularly expandable (over 3000 total channels) to meet future application demands
- High accuracy analog measurements — even in electrically noisy environments
- Interface to nearly any computer via RS-232-C, RS-422, IEEE-488, or current loop
- Self documenting, structured program language — optimized for measurement and control
- A data acquisition "computer" unto itself — measures, alarms, and controls independent of host
- EPROM program storage available for stand-alone dedicated applications

The 2400B Intelligent Computer Front End is a very accurate microprocessor-based analog and digital data acquisition system with programmable control output signals. The system serves as an interface between a computer and both the measurement and control of a physical process.

The 2400B can receive a measurement and control program (up to 28K bytes) from the host computer and, upon command, execute it without further interaction with the computer. This intelligent system relieves the host of routine, time consuming tasks and greatly simplifies the programmer's task of developing system software. Cost savings is the result, and greater throughput is possible because the computer can perform other tasks at "computer speed" without waiting for physical events.

The 2400B works well in applications requiring a *distributed* data acquisition and control system. With a Serial Interface Option (-001) 2400Bs may be located over 1220 meters (4000 feet) from the host computer in a star or daisy chain configuration.

Computers with which the 2400B will interface are those with either RS-232-C, RS-422, IEEE-488, or 20 mA current loop compatibility. The Fluke 1722A Instrument Controller interfaces well with the 2400B and the combination (called a 2452MCS) is described in the preceding pages.

Hardware costs are reduced by having a wide range of user-configurable, input and output plug-in circuit cards plus different types of extender chassis and interface options to perform the necessary measurement and control functions of your application. The 2400B has a maximum system capacity of over 1000 analog inputs, 1000 digital inputs, 128 analog outputs, and 1000 digital outputs.

### Inputs

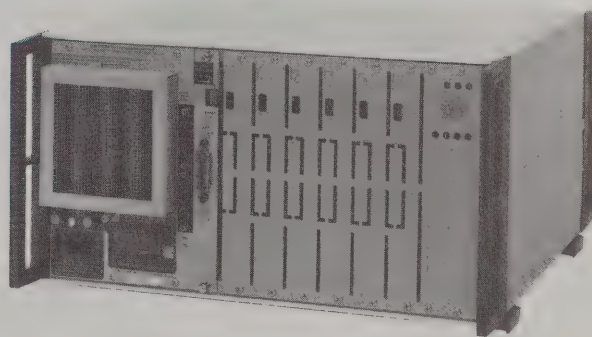
The 2400B accepts inputs from a wide variety of sources and transducers. For analog inputs, the 2400B uses its 17-bit analog-to-digital converter to perform accurate measurements of ac or dc voltage, current, or temperature using thermocouples. Integral signal conditioners are used in conjunction with the A-to-D converter to perform measurements of resistance, temperature (RTDs), and strain, or certain other transducers.

Built-in linearizations are available for a wide variety of thermocouples. RTD linearizations are software-selectable by individually programming the parameters for different probes, assuring best possible accuracy.

Totalizing, as well as frequency, period, and rotation speed measurements, are performed with one of the Counter/Totalizer Options. To sense switch closures or logic levels, you may use the Status Input Option. Or, for faster response, use the Interrupt Input Option or the Sequence of Events Recorder Option. The Interrupt Option causes the 2400B to respond to fast-changing events immediately while the Sequence of Events Option records events with up to 0.1 millisecond resolution. The Digital Input Option is used to read either 7-digit BCD or 24-bit binary words from devices with that output capability.

### Outputs

The 2400B makes use of five different control output options. To light annunciators, or perform on-off control, use the Status Output Option or the Relay Output Option. Use the 2400B's other output cards for more complex process control. A Resistance Output Option may be programmed to supply output resistances from 0 to 100,000 ohms. For -10V to +10V dc or 4 to 20 mA control loops, or driving analog recorders, use the Analog Output Option. To control stepper motors, use the Stepper Motor Output Option. Frequency and acceleration or deceleration rates may be selected through the 2400B's software for stepper motor control.



2400B rear panel showing optional IEEE-488 interface and dual RS-232-C output only ports.

### Expandability

A 2400B system may be large or small, depending upon the application. The 2400B mainframe has six slots for any combination of input, output, or interface plug-in modules. To expand the system, just add extender chassis. However, only one A-to-D converter is needed for a 2400B system to measure analog signals, even if the maximum number of channels is installed.

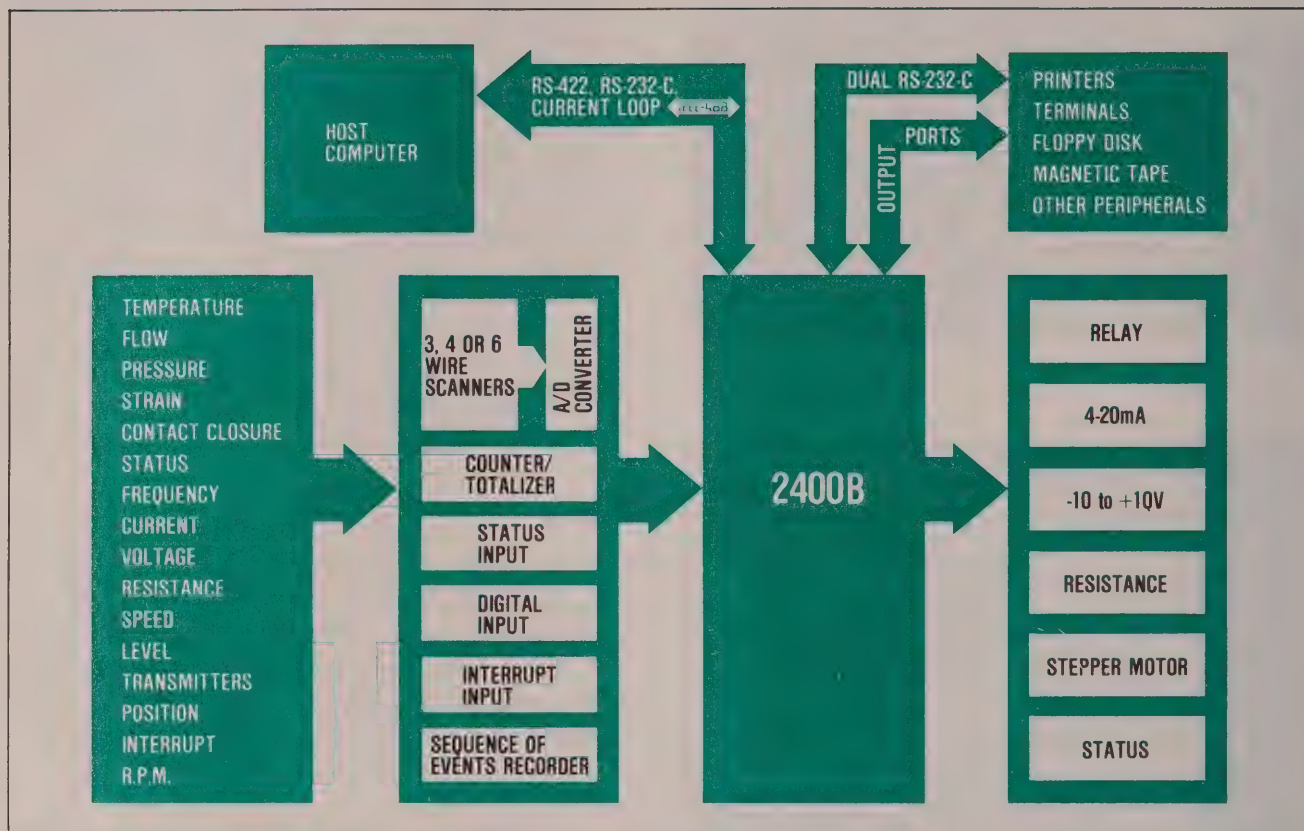
Several 2400Bs may be interfaced to a single computer. When equipped with either the RS-422, or 20 mA current loop interface, 2400Bs may be arranged in a multi-drop configuration at distances up to 1220 meters (4000 feet) from the host computer. Greater distances are possible utilizing the 2400B's RS-232-C interface and modems, over existing telephone lines.



# MEASUREMENT & CONTROL PRODUCTS

## 2400B Intelligent Computer Front End

### 2400B System Diagram



### Flexible Software

The 2400B can be utilized with two "levels" of software. The first level is for immediate-mode commands, those which cause an immediate response from the 2400B. The second level is the program stored in the 2400B, allowing the 2400B to monitor and measure inputs, perform calculations, make decisions, and set control outputs, all independent of the host computer.

#### Immediate Mode

Immediate-mode (host) commands cause an immediate response in the 2400B. For instance, if the host computer tells the 2400B to:

```
SEND AI(16)!
```

the 2400B will perform a reading on analog input channel 16 and return the result to the host computer. (Immediate-mode commands end with the "!" character). The command

```
AO(0)=0.155*AI(2)-1.2!
```

will cause the 2400B to read Analog Input channel 2, multiply it by 0.155, subtract 1.2 and set Analog Output channel 0 to that value.

To gain maximum flexibility from the 2400B's wide range of input and output options, the definition-bus command is used (DEFN). To define analog input channels 10 through 29 as type "J" thermocouples, you would send the 2400B the following command:

```
DEFN
  AICHAN=10 TO 29,SENSOR=TC,TYPE=JNBS;
```

This command, however, differs from the previously discussed commands: It is stored in the 2400B's memory, and is used whenever readings on channels 10 to 29 are requested. So, when the command

```
SEND AI(11)+AI(15)!
```

is sent to the 2400B, the measurements (complete with autozero, range selection, and thermocouple linearization) would be performed on analog inputs 11 and 15, returning the sum to the host in degrees Celsius.

#### Stored Program Operation

The second level of 2400B software is the stored program, a set of instructions downloaded to the 2400B at start-up. This program allows the 2400B to operate independently, with only occasional communication with the host computer. A full set of mathematical functions enables the 2400B to perform complex linearizations, data averaging, proportional integral derivative loops, and more, on its own.

The "IF-THEN-ELSE" statement allows conditional execution of statements or program segments. LOOP and AGAIN statements allow repeated execution of program tasks. The command

```
SCAN POINTS(0), 0 to 199;
```

reads channels 0 to 199 in accordance with their respective definitions with a single instruction, avoiding the necessity of writing a complete subroutine — often necessary in other less intelligent systems.

Experienced programmers will appreciate the modularity and readability added to programs due to function and procedure (subroutine) constructs. Procedures may be called directly from the stored program or invoked by external or time-triggered interrupts.

# MEASUREMENT & CONTROL PRODUCTS

## 2400B Intelligent Computer Front End

Since the stored program is resident in the 2400B itself, communications to the host computer are minimized or non-existent. This results in less complex programs, as well as faster execution speeds. For example, the following simple program performs a complete proportional control loop with limit checking:

```

PROG
SETPT=150;
LIMIT=185;
OFFSET=7.5;
GAIN=0.15;
LOOP;
  TEMP=AI(10);
  IF TEMP > LIMIT THEN SO(6)=1;
  AO(4)=GAIN*(TEMP-SETPT)+OFFSET;
AGAIN;
!
```

In this program, the LOOP and AGAIN cause repeated execution of the three statements nested inside them. The first of these stores the reading on analog input channel 10 in the variable TEMP. If the DEFN statement shown above had been sent to the 2400B prior to execution of this program, this reading would have been in degrees Celsius. Next, the second statement checks to see if the temperature is above the limit. If so, status output 6 will be set to one, which could ring a bell, for instance. Finally, analog output 4 would be set to the voltage computed in the formula.

While this program is executing, a bus command can be used to alter any of the variables used in the program. For instance, the command SETPT=155! could be used to change the setpoint. This capability allows interactive reprogramming of the 2400B, while the 2400B continues program execution.

### Stand-Alone Capability

By loading the 2400B's stored program into EPROMs in the mainframe, the 2400B can be used to monitor inputs, perform calculations, and update control outputs, without being connected to a host computer. Using one or both of the 2400B's RS-232 ports in conjunction with the Fluke 1780A InfoTouch® Display allows stored program data to be presented and modified by an operator, all under the program's control. Approximately 400 lines of 2400B program may be stored in EPROM.

### Worldwide Support

Service centers for Fluke products are located in more than forty countries around the world. Many offer full service contracts for maintenance and repair at your site. Or training for your personnel can be arranged. We know how important it is to be assured of expert maintenance for systems you depend on, even though they may be among the most troublefree available — like those from Fluke.

### Specifications

**Analog Inputs:** ≤1000 isolated, 3-, 4-, or 6-wire channels  
**Digital Inputs:** ≤1024 non-isolated lines, configurable for either (1) 7 BCD digits plus 1 sign bit plus 3 bits for decimal point location or (2) 24-bit binary plus 1 sign bit  
**Status Inputs:** ≤1024 electrically isolated wire-pairs  
**Interrupt Inputs:** ≤32 electrically isolated wire pairs  
**Counter-Totalizer Inputs:** ≤32 isolated analog and ≤32 non-isolated TTL inputs  
**Status Outputs:** ≤1024 electrically isolated wire-pairs  
**Analog Outputs:** ≤128 voltage and/or current sources in range of -10V to +10V or 0 to 20 mA  
**Resistance Outputs:** ≤64 resistance sources with 1Ω increments to 4095Ω and/or 25Ω increments to 102,375Ω  
**Stepper Motor Outputs:** ≤32 direct or logic level outputs

#### 2400B Mainframe

The 2400B must have either option -001 or Option -002 installed to be operational.

**Capacity:** Six slots for any combination of input, output, or extender chassis interface plug-in modules. A-to-D converter module (Option -109) installed in a dedicated additional slot

**CPU:** 16-bit microprocessor, 32K-byte EPROM, 28K-byte user-partitioned RAM

**Serial Outputs:** EIA Standard RS-232-C, two ports, output only

#### Serial Interface Option (-001)

Bi-directional serial interface to compatible host computer. This option is configurable as either an RS-232-C, RS-422, or 20 mA current loop via a changeable jumper. As an RS-232-C interface, Option -001 supports five protocols. Listed in order of increasing level of error detection capability they are

- Simple terminal
- Simple terminal with XON/XOFF
- Simple terminal with XON/XOFF and timeout
- Blocked format with acknowledgements
- Blocked format with acknowledgements and check character

#### IEEE-488 Interface Option (-002)

Bi-directional IEEE-488 interface to compatible host computer or instrument controller such as Fluke 1722A.

#### 2401A Scanner Extender Chassis

**Capacity:** Ten scanner modules (Option -101, -115, or -117) 100 analog input channels

**System Size:** Ten 2401As maximum

**Maximum Distance:** 15 meters (50 feet) from 2400B or 2403A

**Power:** From 2400B or 2403A

#### 2402A I/O Extender Chassis

**Capacity:** 12 input and/or output plug-in modules

**System Size:** 16 2402As, maximum

**Maximum Distance:** 15 meters (50 feet) from 2400B

**Power:** Line power required

#### 2403A Remote A/D Extender Chassis

**Capacity:** Eight slots for signal conditioners, scanner modules (Option -101, -115 or -117) plus two slots for Interface Options (-401) for up to ten 2401s. One A/D module required (Option -109)

**Maximum Distance:** 1220 meters (4000 feet) from 2400B

**Power:** Line power required

#### High Performance A/D Converter Option (-109)

Required for all analog measurement inputs. Only one allowed for each 2400B System.

**Input Resistance:** >200 MΩ in 0.1V, 0.8V, and 6.4V range; 10 MΩ in 100V range

**Input Capacitance:** 0.005 μF at 25 readings per second; 0.5 μF at 3 readings per second

**Zero Stability:** Automatically zeroed before each measurement

**Overrange:** Autoranges, unless autorange defeated. Overload causes front panel ERROR light to turn on and message available to host computer

### Voltage, Current, Thermocouple Inputs

#### High Performance Scanner Option (-101)

Ten 3-wire dry reed relays (Hi, Lo, shield).

**Life:** Rated for >10<sup>8</sup> operations with ≤50V ac rms applied; >10<sup>7</sup> operations with ≤250V ac rms applied

**Thermal Offset:** <1 μV per channel

**Maximum Voltage:** 350V dc or peak ac between any input terminal and system ground or other terminal

#### Thermocouple and DC Voltage Input Connector Option (-102)

Ten 3-wire sets of screw terminals on isothermal block enclosed in a snap-apart plastic safety housing. Integral reference junction correction for 0°C. Plugs into Scanner Module (Option -101).

**Temperature Resolution:** 0.1 degree (one count).



# MEASUREMENT & CONTROL PRODUCTS

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### Temperature Measurement Accuracy

Measurement may be performed in Celsius, Fahrenheit, Kelvin, or Rankine

Thermo-couple Type	Measured Temperature °C	Maximum Instrument Error (±°C)*					
		24 Hours 21°C-25°C Rdgs/Sec 3 25		90 Days 18°C-28°C Rdgs/Sec 3 25		1 Year 13°C-33°C Rdgs/Sec 3 25	
J	-200 to +200	0.2	0.3	0.25	0.35	0.3	0.4
NBS	+200 to +760	0.2	0.3	0.35	0.45	0.4	0.5
K	-225 to +200	0.2	0.3	0.25	0.35	0.3	0.4
NBS	+200 to +1350	0.2	0.3	0.4	0.5	0.5	0.6
T	-230 to +200	0.2	0.3	0.25	0.35	0.3	0.4
NBS	+200 to +400	0.2	0.3	0.25	0.35	0.3	0.4
E	-250 to +250	0.2	0.3	0.25	0.35	0.3	0.4
NBS	+250 to +1000	0.2	0.3	0.35	0.45	0.5	0.6
R	0 to +200	0.4	0.65	0.9	1.15	1.1	1.35
NBS	+200 to +1767	0.4	0.65	0.7	0.95	0.9	1.15
S	0 to +200	0.4	0.65	0.9	1.15	1.1	1.35
NBS	+200 to +1767	0.4	0.65	0.7	0.95	0.9	1.15
B	+200 to +1820	0.4	0.75	0.7	1.05	0.9	1.25
J	-200 to +200	0.2	0.3	0.25	0.35	0.3	0.4
DIN	+200 to +900	0.2	0.3	0.35	0.45	0.4	0.5
T	-200 to +200	0.2	0.3	0.25	0.35	0.3	0.4
DIN	+200 to +600	0.2	0.3	0.25	0.35	0.3	0.4
R	0 to +200	0.4	0.65	0.9	1.15	1.1	1.35
JIS	+200 to +1770	0.4	0.65	0.7	0.95	0.9	1.15
N**	-200 to +200	0.2	0.3	0.25	0.35	0.3	0.4
NBS	+200 to +1300	0.2	0.3	0.4	0.5	0.5	0.6
C***	0 to +2315	0.4	0.55	0.7	0.85	0.9	1.05

\* Includes all but sensor error: Connector gradient, reference junction, linearization conformity, A-to-D conversion, temperature coefficient, time drift, scanner offset.

\*\* Nicrosil/Nisil

\*\*\* Hoskins Mfg. Co. Tungsten - 5% Rhenium vs Tungsten - 26% Rhenium

### DC Voltage Input Connector Option (-108)

Ten 3-wire sets of screw terminals for input wires enclosed in snap-apart plastic safety housing. Plugs into scanner module (Option -101)  
Range: -100V to +100V

Maximum Voltage: 350V dc or peak ac. See Option -101

DC Voltage Measurement Accuracy:  $\pm(\% \text{ Rdg} + \text{Counts} + \mu\text{V})^*$

Readings per sec	24 Hours 21°C to 25°C	90 Days 18°C to 28°C	1 Year 13°C to 33°C
0.1V, 0.8V, 6.4V Ranges			
3	$\pm(0.002\%+2+2)$	$\pm(0.005\%+3+2)$	$\pm(0.01\%+4+6)$
25	$\pm(0.002\%+4+4)$	$\pm(0.005\%+5+4)$	$\pm(0.01\%+6+6)$
100V Range			
3	$\pm(0.008\%+2+0)$	$\pm(0.01\%+3+0)$	$\pm(0.02\%+4+0)$
25	$\pm(0.008\%+4+0)$	$\pm(0.01\%+5+0)$	$\pm(0.02\%+6+0)$

\* After 45 minute warm-up. With Option -109, -101, and -108 (or -102)

### AC Voltage Input Connector Option (-119)

Ten sets of 2-wire screw terminals for input wires enclosed in snap-apart safety housing. Plugs into scanner module (Option -101).

Voltage Range: 5V rms to 250V rms

Frequency Range: 45 Hz to 450 Hz

Conversion Method:  $\frac{1}{2}$ -wave, average-responding, calibrated to indicate rms value of sine wave

Maximum Voltage: 250V rms or 250V dc

Accuracy:  $\pm(1.0\% \text{ of input} + 0.1\text{V})$

### Current Input Connector Option (-106)

Specifications are the same as for Option -101 but with a precision 15 $\Omega$ , 0.25 watt resistor in each channel to convert current to voltage. For 4 to 20 mA sources; 129 mA maximum. Plugs into Scanner Module (Option -101). Some other current values available on request.

### RTD's, Ohms, $\frac{1}{4}$ -Bridge Strain Inputs

#### Ohms Mode Specifications

Max Resistance	Resolution	Excitation Current
64,000 $\Omega$	1.0 $\Omega$	100 $\mu$ A
8000 $\Omega$	0.1 $\Omega$	100 $\mu$ A
800 $\Omega$	0.01 $\Omega$	1 mA
100 $\Omega$	0.001 $\Omega$	1 mA
10 $\Omega$	0.0001 $\Omega$	10 mA

Total System Accuracy: For 90 days, 18°C to 28°C, at 25 readings per second —

Four-Wire:  $\pm(0.021\% \text{ of reading} + 0.01\% \text{ range})$

Three-Wire:  $\pm(0.021\% \text{ of reading} + 0.02\% \text{ range} + 0.21\Omega)$

#### RTD Mode Specifications

Resolution: 0.03°C

Total System Accuracy: For 90 days, 18°C to 28°C, at 25 readings per second, 4-wire —

100 $\Omega$  Pt RTD with  $\alpha = 0.00385$ :  $\pm 0.2^\circ\text{C}$  at 0°C;  $\pm 0.3^\circ\text{C}$  at 600°C

#### $\frac{1}{4}$ -Bridge Strain Mode Specifications

For 90 days, 18°C to 28°C, at 25 readings per second, 350 $\Omega$  gage.

Total System Accuracy:  $\pm(0.042\% \text{ of reading} + 2.7 \text{ microstrain})$

Resolution: 0.2 microstrain

Temperature Coefficient:  $\pm(0.003\% \text{ of reading} + 0.36 \text{ microstrain}) \text{ per } ^\circ\text{C}$

#### Signal Conditioner Option (-701)

For Ohms, RTD,  $\frac{1}{4}$ -bridge strain measurements.

Configuration: 3- or 4-wire, switch-selectable

Excitation Currents: 100  $\mu$ A, 1 mA, 10 mA, switch-selectable

Accuracy:  $\pm 0.005\%$  at calibration, 21°C to 25°C

#### Four-Wire Scanner Option (-115)

Capacity: Ten 4-wire channels (reed relays)

Life:  $>10^8$  operations with  $<50\text{V}$  applied;  $>10^7$  operations with  $<170\text{V}$  peak applied

Noise Rejection: Same as Option -109 except common mode rejection is 120 dB and normal mode rejection is 60 dB

Maximum Voltage: 170V dc or peak ac between any channel and any other channel and/or ground. 30V dc or rms ac between any two lines on the same channel

Connector Option: Use 2400A-116

Note: This scanner may not be used for voltage measurements.

#### Four-Wire Input Connector Option (-116)

Ten 4-wire sets of screw terminals for input wires enclosed in snap-apart plastic safety housing. Plugs into Scanner Module Option (-115)

Maximum Voltage: Same as for Option -115.

Note: This connector may not be used for voltage measurements.

### $\frac{1}{2}$ - and Full-Bridge Strain Measurements

#### Total System Accuracy\*

$\frac{1}{2}$ -Bridge Mode:  $\pm(0.015\% \text{ of rdg} + 4.5 \text{ microstrain})$  with both gages principally active

Full-Bridge Mode:  $\pm(0.015\% \text{ of rdg} + 4.5 \text{ microstrain})$  with two gages principally active

\* For 90 days, 18°C to 28°C, 25 readings per second, 350 $\Omega$  gage, 4V excitation

Resolution: 0.5 microstrain

Temperature Coefficient:  $\pm(0.002\% \text{ of reading} + 0.5 \text{ microstrain}) \text{ per } ^\circ\text{C}$

## MEASUREMENT &amp; CONTROL PRODUCTS

## 2400B Intelligent Computer Front End

**Signal Conditioner Option (-702)**

For ½- and full-bridge strain measurements

**Excitation Voltage:** 4, 5, 8, 10, 12, 15, or 20V dc, software-selectable

**Six-Wire Scanner Option (-117)**

**Capacity:** Five 6-wire channels (reed relays)

**Conductors:** Excitation source (2); remote sense (2); analog input (2)

**Life:** >10<sup>8</sup> operations with <50V applied; >10<sup>7</sup> operations with <170V peak ac applied

**Noise Rejection:** Same as Option -109 except common mode rejection is 120 dB and normal mode rejection is 60 dB

**Maximum Voltage:** 170V dc or peak ac between any channel and any other channel and/or ground. 30V dc or rms ac between any two lines on the same channel.

**Connector Option:** Use 2400A-118

**Six-Wire Input Connector Option (-118)**

Five 6-wire sets of screw terminals for input wires enclosed in snap-apart safety housing. Plugs into six-wire scanner module Option -117

**Other Input Specifications****Counter/Totalizer Signal Input Option (-113)**

May be used to perform the following measurements: Frequency, period, totalize, tachometer, "A" gated by "B", and time interval. **Inputs:** TTL, Gate 1, Gate 2, Trigger, Count Up, Count Down, Up/Down, Count, Non-Isolated Common, Isolated Common, Isolated Analog Input

**Isolation:** Both Analog Input and Isolated Common are isolated from the 2400B and/or ground up to 30V and up to 1.0 V/μs maximum slew rate

**Frequency Range:** 0 to 900 kHz (TTL Input); 10 Hz to 200 kHz (Analog Input)

**Period Range**

TTL Input: 1.1 μs to 6.7s

Analog Input: 5 μs to 0.1s

**Period Resolution:** 400 ns

**Time Interval Range**

TTL Input: 1 μs to 3.82 hr

Analog Input: 2 μs to 50 ms

**Time Interval Resolution:** 819 μs (≤3.82 hours); 400 ns (≤6.7 seconds)

**Totalizer Input Range:** Dc to 900 kHz

**Minimum Pulse Width:** 400 ns

**Totalizer Capacity:** -8,388,608 to +8,388,607

**Connector:** 12 conductors, supplied with option (screw terminals)

**4 Channel Counter/Totalizer Option (-113/AA)**

Measures period, frequency, time interval, and totalizes

**Inputs:** Four channels, non-isolated

**Frequency Range:** 0-500k Hz

**Period Range:** 10 μs to 50,000s

**Totalizer Capacity:** 4,999,999

**Max Input Voltage:** 100V peak

**Connector:** 12 conductors, (supplied) screw terminals

**Digital Input Module Option (-103)**

**BCD Mode:** 7 BCD digits +1 sign +3 decimal position bits

**Binary Mode:** 24 bits +1 sign bit

**Logic Level:** TTL, 0 to +0.75V low, +2.5 to +8V high

**Rate:** ≤250 words per second

**Connector Options:** Use 2400A-110 or 2400A-111

**Status Input Module Option (-104)**

**Bits per Module:** 32, isolatable from system ground or other modules by up to 30V dc or peak ac

**Format:** Individually readable

**Input:** Contact closures or TTL level

**Connector Option:** Use 2400A-110 or 2400A-111

**Sequence of Events Recorder Option (-104/AA)**

**Number of Inputs:** 32 channels

**Channels Per System:** 1024 max

**Resolution:** 0.1 ms to 100 ms, selectable

**Interrupt Signal Input Option (-114)**

**Number of Inputs:** 16, isolated in common from the 2400A and/or system ground up to 30V dc or peak ac and 1.0 V/μs maximum slew rate

**Input Logic:** Contact closures or TTL level, switch-selectable

**Direct Input Sensitivity:** Pulse duration >20 μs

**Input Debounce:** 5 ms to 88 ms, switch-selectable

**Interrupt Transition:** Software-selectable by input

**Connector Option:** Use 2400A-110 or 2400A-111

**Screw Terminal Connector Option (-110)**

**Terminals:** 50, for wire sizes up to #14 AWG

**Solder Pin Cable Connector Option (-111)**

**Terminals:** 50, for wire sizes up to #22 AWG

**Control Output Specifications****Analog Control Output Option (-302)**

**Outputs:** Isolated. Four per module. Voltage (-10V to +10V) or current (0 to 20 mA), individually selectable

**Resolution:** 2 mV (13 bits) or 5 μA (12 bits)

**Isolation:** ≤30V dc or peak ac, channel to channel

**Max Load:** ±5 mA in voltage mode; ≤750Ω in current mode

**90-Day Accuracy:** ±20 mV in voltage mode and ±20 μA in current mode for ambient temperature of 18°C to 28°C

**Rate:** 250 changes per second

**Connector Option:** Use 2400A-110 or 2400A-111

**Status Output Control Option (-301)**

**Outputs:** 32, open collector, diode clamped. 100 mA at ≤1.1 volt each. Common return line.

**Isolation:** ≤30V dc or peak ac, channel to channel or channel to ground

**Rate:** Set or reset at 250 bits per second

**Connector Option:** Use 2400A-110 or 2400A-111

**Relay Output Card Option (-301/AA)**

**Number of Contacts:** 16

**Contact Rating:** 250V ac at 3A with non-inductive load and 28V dc at 3A

**Contact Arrangement:** Form "C" (N.O. or N.C.)

**Connector:** Connector block integral to Option -301/AA (screw terminals)

**Resistance Output Control Option (-305)**

**Outputs:** Two

**Isolation:** ≤30V dc or peak ac channel to channel or channel to ground

**Values:** 0 to 4095Ω in 1Ω increments

**Power Dissipation:** 0.125W maximum

**90-Day Accuracy:** ±0.1% of full scale 18°C to 28°C ambient

**Connector:** Four screw terminals, supplied

**Resistance Output Control Option (-306)**

**Outputs:** Two

**Isolation:** ≤30V dc or peak ac, channel to channel or channel to ground

**Values:** 0 to 102,375Ω in 25Ω increments

**Power Dissipation:** 0.125W maximum

**90-Day Accuracy:** ±0.1% of full scale 18°C to 28°C ambient

**Connector:** Four screw terminals, supplied

**Stepper Motor Control Output Option (-307)**

**Number of Outputs:** One, non-isolated

**Input Signals:** External Enable, Closed-Loop Feedback

**Input Logic:** Contact closure or TTL level

**Direct Output Signals:** Four-Phase Unipolar Drive, Flyback Protected

**Direct Output Current:** 375 mA maximum

**Logic Output Signals:** CW/CCW direction and Step Clock, or CW and CCW Clock Outputs; Busy/Done

**Output Logic:** Open-collector TTL outputs. Interface to voltages up to 20V dc

**Output Pulses:** 1 to 1,048,575 CW or CCW

**Slew Frequency:** 1 Hz to 25.6 kHz, software-selectable

**Acceleration and Deceleration Rates:** 114 Hz/second to 97656 Hz/second. Software-selectable

**Connector:** 12 screw terminals, supplied with option

*Note: Option -307 may be configured as a frequency source. Ask about Option -307/ABK*



# MEASUREMENT & CONTROL PRODUCTS

## 2400B Intelligent Computer Front End

### General Specifications

**Shock and Vibration:** Meets MIL-T-28800C, Class 3 requirements

**Temperature:** 0°C to 50°C, operating; -20°C to +70°C, non-operating

**Relative Humidity:** ≤80% to 40°C and ≤70% to 50°C, operating, non-condensing

**Power:** 90 to 132V ac or 180 to 264V ac, switch-selectable, 50 or 60 Hz ±2 Hz

**Size:** 22 cm H x 43 cm W x 38 cm D (8.66 in x 16.9 in x 14.96 in) for 2400B, 2401A, 2402A, and 2403A. Fit standard 19-inch rack

### Weight

2400B: 11.4 kg (25 lb)

2401A: 6.4 kg (14 lb)

2402A: 11 kg (24 lb)

2403A: 8.2 kg (18 lb)

\*Approximate, fully loaded

### Models

January 1985 prices

2400B Intelligent Computer Front End	\$4390
2401A Scanner Extender Chassis	1390
2402A I/O Extender Chassis	2260
2403A Remote A/D Extender	1710

### Options

2400B-001 Serial Interface	690
2400B-002 IEEE-488 Interface	690
2400A-101 High Performance Scanner	450
2400A-102 Thermocouple & DC Voltage Input Connector	195
2400A-103 Digital Signal Input	440
2400A-104 Status Signal Input	530
2400A-104/AA Sequence of Events Recorder	on req.
2400A-106 Current Input Connector	225
2400A-108 DC Voltage Input Connector	135
2400A-109 High Performance A/D Converter	1990
2400A-110 Screw Terminal I/O Connector	135
2400A-111 Solder Pin I/O Connector	45
2400A-113 Counter/Totalizer Signal Input	630
2400A-113/AA 4 Channel Counter/Totalizer	on req.
2400A-114 Interrupt-Signal Input	550

2400A-115 Four-Wire Scanner	485
2400A-116 Four-Wire Input Connector	135
2400A-117 Six-Wire Scanner	535
2400A-118 Six-Wire Input Connector	135
2400A-119 AC Voltage Input Connector	215
2400A-301 Status Output	510
2400A-301/AA Relay Output	on req.
2400A-302 Current/Voltage Analog Output	1335
2400A-305 Resistance Output (1Ω to 4 kΩ)	660
2400A-306 Resistance Output (25Ω to 100 kΩ)	660
2400A-307 Stepper Motor Control Output	695
2400A-401 Scanner Extender Interface	155
2400A-402 Extender Cable (custom length)	25
2401A-403 Connectors for 2400A-402 Cable	205
2402A-501 I/O Extender Interface	310
2402A-502 I/O Cable (with connectors, 9m)	295
2403A-601 Remote A/D Extender Interface	270
2403A-602 A/D Extender Cable (custom length)	5
2403A-603 Connectors for 2403A-601 Cable	70
2400A-701 Signal Conditioner for Ohms, RTD's	
1/4- & 1/2-Bridge Strain Measurements	530
2400A-702 Signal Conditioner for 1/2- and	
Full-Bridge Strain Measurements	635

### Accessories (Also see page 230)

1780A InfoTouch® Display	1995
Y1707 2m Cable for RS-232-C	125
Y1705 RS-232-C Null Modem Cable	75
Y8022 2m Cable for IEEE-488	95
Y2053 Rack Adapter w/24" slides	195
Y2054 24" Rack Adapter w/o slides	120
Y2055 RS-422 Multi-connector	95

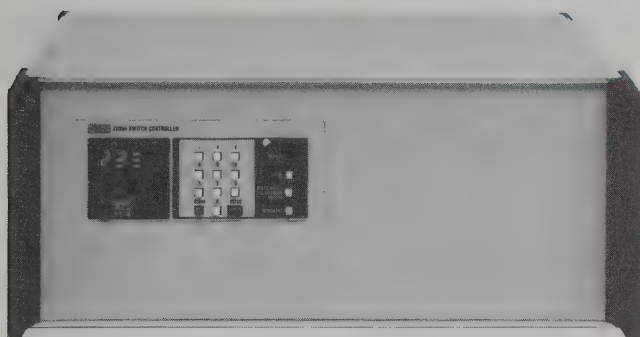
### After-Warranty Service (See page 227)

SC1-2400B, per 90-day interval	772
SC1-2401A, per 90-day interval	268
SC1-2402A, per 90-day interval	324
SC1-2403A, per 90-day interval	440

On-Site Service Agreement available

## SWITCH CONTROLLER

2205A



2205A

## 2205A Switch Controller

- Plug-in modules that expand the versatility of the 2205A
- Channel expansion (up to 1000)
- Matrix latching
- Low level and thermocouple scanning
- Two-wire or four-wire resistance scanning
- Actuator/Relay control
- Remote operation via IEEE-488 or RS-232-C interface options

## Versatile Switching, Latching, Scanning

The microprocessor-based 2205A Switch Controller offers a wide variety of switching, scanning, and matrix-latching capabilities for applications in production testing, process monitoring, process automation, calibration, etc.

The 2205A may be operated or programmed from the front panel to perform periodic switching operations. Or it may be directed remotely in a system compatible with IEEE Std 488-1978 or EIA Standard RS-232-C to perform complex switching operations.

## Five Switching Options

Five kinds of switching module options are available. They plug into the 2205A mainframe and any combination of up to ten modules may be plugged in at the same time. Model 2201A Extender Chassis allows for expansion of a system to accommodate up to 100 modules.

Three of the five types of switching options are for scanning analog signals. One of the three is for measuring low level signals such as the output voltage from thermocouples (-600), one is for general-purpose scanning (-300), and one is for measuring resistances using 4-wire connections (-400). Four wires are needed for precision measurements of low resistance values through long input wires. The latter option uses a pair of modules: a general-purpose module for the current-source leads and a low-level module for the voltage-sense leads.

Each module has ten reed relays and will scan ten points. The low-level reed relays switch a guard line as well as a pair of input leads.

Option -100 is an actuator module with five medium-power relays for controlling external and remote devices like indicators, actuators, alarms, power supplies, and other relays.

Option -200 is a matrix latching module that may be configured in one of three ways: either as a 1 by 8 matrix, as two 1 by 4 matrixes, or as a 2 by 4 matrix. This option features an 8 millisecond break-before-make switching speed and less than 10 microvolts of thermal offset.

## Integrated Stimulus, Measurement, Control

The modularity of the 2205A makes it easy to configure switching in numerous ways. And that makes it a worthy building block for automated systems of various kinds. With either the RS-232-C Option (-060) or the IEEE-488 Option (-050), the 2205A can become an integral part of a sophisticated system. Fluke offers numerous IEEE-488-compatible instruments including the 1722A Instrument Controller, signal sources, power sources, calibrators, digital voltmeters, counters, thermometers, data loggers, and printers.

## 2205A Specifications

**Control:** Manual, panel-programmed scan, or via RS-232-C or IEEE-488 Interface Option

**Panel Controls:** Select channels to be scanned, actuated, or latched. Scan rate selectable in 0.1 second increments from 0.2 seconds to 3.3 seconds per channel using behind-the-panel control.

**Switch-Module Slots:** Ten, expandable to 100 using several 2201A (12-slot) Extender Chassis

**Display:** 3-digit LED. Shows active channel number. Also shows assigned address (using IEEE-488 Interface), or selected baud rate (using RS-232-C Interface) at time of power-up.

**Trigger Output:** Rear panel BNC connector. TTL level. Adjustable delay. To trigger measurements following moments when switching occurs.

**Analog Output:** To digital multimeter via rear panel output connector. Guarded 2-wire or guarded 4-wire connections. Common-mode voltage 170V dc or peak ac.

**Other Inputs and Outputs:** Via module connectors included with modules  
**Internal Scanning Bus:** Two 3-wire buses. One is common to even-numbered module slots; the other is common to odd-numbered slots. Goes to analog output. Input resistance is greater than 10 GΩ on HI or LO with respect to power line ground.

## 2201A Specifications

**Switch-Module Slots:** 12 in each 2201A. Up to 100 slots (1000 channels) per system.

One or more 2201A Extender Chassis may be connected to a 2205A via a six-foot cable supplied with each 2201A. Power and control for the modules is supplied by the 2205A.

## 2202A Specifications

**Switch Module Slots:** 10 in each 2202A. Up to 100 slots (1000 channels) per system.

Power for the modules is supplied from an ac line via internal dc supply. Requires 2200A-7001 and 2200A-7002 cable.

## Option Specifications

## Actuator Control Module Option (-100)

**Relays:** Five, SPDT

**Switching Time:** 20 ms

**Contact Rating:** 1A maximum at up to 26V dc or 30V rms ac. 3A fuse in each common line

**Connectors:** Screw terminals, three lines per relay. Terminals are mounted on an edge-card connector that plugs onto, and is easily removed from, the module circuit card.

## Matrix Latching Module Option (-200)

**Relays:** Eight, latching, DPST with unswitched guard, break-before-make

**Switching Time:** 8 ms

**Rating:** 40 mA maximum to 170V dc or peak ac, max

**Bandwidth:** Dc to 1 MHz ( $\pm 0.1$  dB) into 600Ω to 1 MΩ load

**Thermal Offset:**  $< 10 \mu V$

**Configurations:** One 2x4 matrix, two 1x4 matrixes, or one 1x8 matrix

**Connectors:** Screw terminals, three lines per relay. Terminals are mounted on an edge-card connector that plugs onto, and is easily removed from, the module circuit card.



# SWITCH CONTROLLER

## 2205A

### General-Purpose Scanning Module Option (-300)

**Relays:** Ten, reed type, DPST with unswitched guard

**Scan Rate:** 125 channels per second, maximum

**Rating:** 40 mA maximum. A 0.5A fuse in each input line

**Thermal Offset:** <10  $\mu$ V

**Connectors:** Screw terminals, three lines per relay. Terminals are mounted on an edge-card connector that plugs onto, and is easily removed from, the module circuit card.

### Low-Level Scanning Module Option (-600)

**Relays:** Ten, reed type, 3PST, switched guard

**Scan Rate:** 80 channels per second, maximum

**Rating:** 15 mA maximum to 35V peak

**Reference Junction Output:** 540 mV at 25°C

**Thermal Offset:** <1  $\mu$ V

**Connectors:** Screw terminals on isothermal block to minimize temperature differences between terminals when scanning thermocouples. Reference junction temperature-sensing circuit on isothermal block provides automatic compensation to thermocouple output signals. Terminals are mounted on edge-card connector that plugs onto, and is easily removed from, the module circuit card.

### Four-wire Ohms Option (-400)

Two modules per option, used in adjacent slots. Switch both current-source and voltage-sense connections for precision resistance measurements. Specifications for current sourcing are the same as for Option -300. Specifications for voltage sensing are the same as for Option -400 except reference junction temperature sensing circuits are not available.

### RS-232-C Interface Option (-060)

Serial interface with a baud rate of 110, 134.5, 150, 300, 600, 1200, 2400, or 4800.

### IEEE-488 Interface Option (-050)

For use in IEEE-488-compatible systems.

**Repertoire:** AH1, L2, RL1, DC1, E2

## General Specifications

**Temperature:** 0°C to 50°C, operating; -55°C to +75°C, non-operating

**Relative Humidity:** <80% to 40°C, operating

**Power:** 100, 120, 220, or 240V ac  $\pm 10\%$ , 50 to 60 Hz, selectable from rear panel. 25W maximum

**Size:** 17.8 cm H x 43.2 cm W x 44 cm D (7 in x 17 in x 17.4 in)

**Weight:** 7.1 kg (15.6 lb)

### Included

2205A: Manual, power cord, Y8076 analog output cable for 8502A-16, 8505A, 8506A, 8520A, or 8860A-06 DMM

2201A: Manual, six-foot cable for connecting to 2205A

2202A Manual, power cord but no cable

## Models

January 1985 prices

2205A Switch Controller .....	\$1850
2201A Extender Chassis .....	1495
2202A Extender Chassis .....	1795

## Options

2205A-050 IEEE-488 Interface .....	270
2205A-060* RS-232-C Interface .....	270
2205A-100 Actuator Control .....	320
2205A-200 Matrix Latching .....	320
2205A-300 General-Purpose Scanning .....	320
2205A-400 4-Wire Ohms Scanning .....	720
2205A-600 Low-level Scanning .....	400

\*Can't be used with Option -050

## Accessories (Also see page 230)

2205A-110K Spare Actuator Card .....	250
2205A-010K Spare Actuator Connector .....	110
2205A-610K Spare Low-Level Scanner Card .....	300
2205A-008K Spare Low-Level Connector .....	110
2205A-310K Spare General-Purpose Scanner Card .....	250
2205A-009K Spare General-Purpose Connector .....	110
2205A-210K Spare Matrix Latching Card .....	250
2200A-7001* Connector and Assembly of -7002 .....	165
2200A-7002* Remote Scanner Cable (per foot) .....	5
Y8021 1m Cable for IEEE-488 Bus .....	85
Y8022 2m Cable for IEEE-488 Bus .....	95
Y8023 4m Cable for IEEE-488 Bus .....	105
Y8004 1.5m RS-232-C Cable .....	105
Y8013 Trigger Output Cable .....	25
Y8076 Analog Interface Cable (Included with 2205A) .....	125
M07-205-600 7" Rack Adapter .....	100
M00-260-610 18" Rack Slides (needs M07-205-600) .....	105
M00-280-610 24" Rack Slides (needs M07-205-600) .....	110

\*-7001 and -7002 both required

## After-Warranty Service (See page 227)

SC1-2205A, per 90-day interval .....	356
SC1-2201A, per 90-day interval .....	220
SC1-2202A, per 90-day interval .....	356

# MICRO-SYSTEM TROUBLESHOOTERS

## Introduction

### 9000A Micro-System Troubleshooter

The 9005A, 9010A, and 9020A are Fluke's solution for the most difficult type of troubleshooting tasks; the kind associated with microprocessor ( $\mu$ P) based circuits or UUTs.

The 9000 Series Micro-System Troubleshooters offer an affordable, easy-to-use and effective choice for testing and troubleshooting  $\mu$ P based UUTs. Whether you work in a production facility, a centrally located service center or at geographically dispersed depots, these tools can save you valuable time and money. Think of the savings to be gained if you troubleshoot circuits at a service center or depot, and never have to return another circuit board to the factory again!

No software or in-depth knowledge about microprocessors is necessary to use these instruments effectively. Thus, comprehensive testing is available the day you turn on your 9000 Series Troubleshooter. These instruments pinpoint  $\mu$ P circuit faults making what used to be the most difficult faults to isolate — those closely related to the microprocessor bus: RAM, ROM and I/O registers — the easiest.

Fluke's Micro-System Troubleshooters emulate the  $\mu$ P actions on the UUT. The interaction between the 9000 Series Troubleshooters and the UUT is based on the fundamental capability of a  $\mu$ P to read data from, or write data to, an address. Unlike other digital troubleshooting or testing equipment, such as logic analyzers or signature analyzers, the 9000s do not gather information in the time-domain. Through the UUT connection at the UUT  $\mu$ P socket, the 9000 takes control of the UUT  $\mu$ P bus and performs read and write operations anywhere in the UUT address space.

The main instrument is designed to be used with any microprocessor. An interface pod is designed for each  $\mu$ P. This pod provides the 9000 with the necessary  $\mu$ P dependent features. Contained in each pod is a  $\mu$ P of the same type that it replaced in the UUT.

The versatility and utility of the 9000 Series Troubleshooter is enhanced by the wide selection of available interface pods. Microprocessors that are supported by Fluke pods are listed below. Additional microprocessors can be supported by using a pod adapter packaging kit.

Microprocessors currently supported by Fluke pods.

1802	80186	8050	8748
1804	80188	8051	8749
1805	8031	8052	8751
1806	8032	8080	9900
6502	8035	8085A	Z8001
6800	8039	8085A-2	Z8002
68000	8040	8086	Z8003
68010	8041	8088	Z8004
6802	8041A	8344	Z80A
6802NS	8042	8741A	Z80B
6808	8044	8742	
6809	8048	8744	
6809E	8049		

### Fluke Micro-System Troubleshooter Summary

9005A	Micro-System Troubleshooter that uses test programs and learned data downloaded from a Model 9010A or from a pre-recorded mini-cassette loaded into internal memories.
9010A	Micro-System Troubleshooter with self-contained programmability.
9020A	Micro-System Troubleshooter for use in systems with a controller or personal computer via either RS-232-C or IEEE-488. Does not have self-contained programmability; does not use mini-cassettes.



# PRINCIPLES OF OPERATION / STANDARD FEATURES

## Compares System Operation With “Known-Good”

The 9000 Series instruments troubleshoot by comparing “known-good” information of a properly operating system with the system under test. That “known-good” information may be acquired using the learn function or manually entered from the keyboard when microprocessor documentation is available. Once it is acquired, it may be stored on a minicassette (or in a controller/computer memory for the Model 9020A).

## Built-in Tests

With the 9000 Series family of instruments, testing may begin immediately. The troubleshooting philosophy is to begin with the standard interface, the microprocessor socket, and work outwards. With BUS TEST, RAM SHORT TEST, RAM LONG TEST, and ROM TEST the toughest problems, those related to the bus lines, can be found quickly and easily by just knowing the addresses of memory locations. Failures that “lock-up” the microprocessor bus and prevent other testers from doing any further testing do not affect troubleshooting with the 9000 Series instruments. The built-in tests will stop and report the error to the operator. At that time the operator may choose to troubleshoot or, with the special features, ignore the error message and continue testing to determine the root of the problem. Fluke has taken the trouble out of verifying that the kernel, the heart of the microprocessor system, is operating properly.

## Beyond the Bus

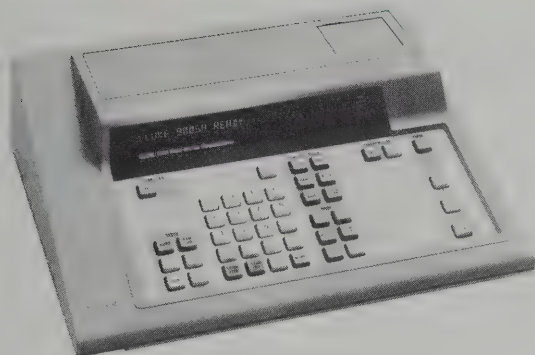
The power of the 9000 Series is not limited to finding the toughest problems — the bus-related problems. It has a troubleshooting probe that lets you either monitor logic action at a node of your choosing or inject stimulus pulses, and it may or may not be synchronous with the microprocessor. This capability takes you into any of the digital circuits not tied directly to the bus. Automatic patterns can be written to any address to stimulate readouts, print heads, interfaces, etc. In the response mode, the probe will take signatures, count events, and show logic states. Test programs can be written to customize the instrument to the system under test and either used immediately or stored on a minicassette for use later. Unskilled operators may be guided directly to the faulty node with such a program. The screen might prompt with: PROBE U26 PIN 6. A “loop” mode lets you zero in on faults and isolate intermittent conditions.

## Troubleshooting Probe

The troubleshooting probe that comes with each instrument plugs into the mainframe and operates in either stimulus or response mode. It can be synchronized to (a) valid address or data periods on the microprocessor bus, (b) interrupt signals, depending on the pod, or (c) a free running 1 kHz trigger. You can take signatures, count events, and show logic state(s) using the probe response mode. It will inject clock-synchronized pulses or 1 kHz pulses at specific nodes. The probe is extremely useful in testing circuitry beyond the bus such as I/O circuits. See specifications (page 215) for details of probe performance.

# MICRO-SYSTEM TROUBLESHOOTERS

## 9000 Series



9005A



9010A

### 9005A/9010A Micro-System Troubleshooters

- Keyboard data entry
- Power-up self test
- 32-digit display
- Testing capability beyond the bus
- Keystroke programming (9010A only)
- Language compiler (9010A only)
- RS-232-C Interface (optional)

The 9005A and the 9010A are troubleshooters designed for ease in locating faults related to the microprocessor bus: RAM, ROM, I/O registers. Each uses the troubleshooting probe to either monitor logic action at a node of your choosing or inject stimulus pulses.

The 9005A performs the same basic functions as the 9010A except it does not have the Learn mode or keys for generating a test program. It operates under keyboard control or from data prerecorded on a minicassette tape and transferred to internal memories. Typically, test routines such as Guided Fault Isolation Programs are developed at a central location with a 9010A and placed on cassette tape. These programs can then be run on 9005As which are utilized at remote sites where technicians can follow the guided troubleshooting routines.

The 9010A offers keystroke programming similar to using a scientific calculator. By combining the 9010A's automated testing and troubleshooting functions you can construct comprehensive routines appropriate to the unique characteristics of each different piece of equipment that must be serviced. Program development and debugging is done directly on line using command keys and arithmetic keys. A minicassette is used to save each program developed, but a program can be downloaded from the cassette later

and tested, edited, and improved. Testing and editing a program on line gives the programmer fast feedback about a test's usefulness. And it gives the test technician an opportunity to locate really difficult faults by quickly creating short new tests.

#### Language Compiler

Off-line programming can be done using a 9010A Language Compiler — available in several versions compatible with the following computer systems: IBM personal computer, Kay Pro II, Fluke 1720A and 1722A Instrument Controllers, and Z80 based CP/M operating systems. This powerful new programming tool lets you write extensive test and troubleshooting routines quickly and more conveniently than ever before. With the use of the editor in these computers, programs can be documented with imbedded comments within the program listing. A File Inclusion allows common test programs to be shared. Keyword abbreviations, optional command keywords and shorthand notations minimize the time and effort required to enter program lines. With the use of symbolic names for programs, labels, or registers, the purpose of various sections of the program becomes easier to understand and remember.



#### Utility Tape 9000A-910

The utility tape contains many programs designed to enhance the operation of the 9010A. Among these software routines are: Merge Tape, Register Addition and Subtraction, Frequency Counter, Setup, Probe Pulser, and Pod Self-Test. The Merge Tape routine allows the user to read specific programs from a cassette tape, renumbering them as desired, adding or "merging" them to programs already in the 9010A. You can combine programs existing on two separate tapes. The Frequency Counter program provides a way to take frequency readings, up to 6 MHz, with the troubleshooter probe. The Setup program allows the 9010A programmer to make changes in the setup menu while under program control. The Probe Pulser program allows the programmer to change the 9010A pulser status while under program control. When you purchase the 9000A-910 Utility Programs, you receive a tape containing Utility Programs, and a manual describing their usage.



# MICRO-SYSTEM TROUBLESHOOTERS

## 9000 Series



9020A

### 9020A Microprocessor Troubleshooter for Systems Use

- Keyboard data entry
- Power-up self test
- 32-digit display
- Test capabilities beyond the bus
- Interfaces with system controller or other computer via RS-232-C or IEEE-488 (no internal memory)

The 9020A is a Micro-System Troubleshooter designed to run test programs written and stored in a system controller. It is basically the same as the 9010A, containing the same built-in tests and troubleshooting keys and use the same probe and pods. The 9020A can perform the built-in self-tests such as the Bus Test, RAM Short, RAM Long, ROM Test and I/O Test and can utilize the troubleshooting keys in the immediate mode. However, it does not contain any programming keys and does not feature a cassette tape capability. To interface with the system controller or another computer for programming, the 9020A has either RS-232-C compatibility or IEEE-488 compatibility; not both.

### The 9020A In A Typical System

To understand how a 9020A could be applied in a testing situation, consider a typical system as illustrated in the block diagram (Figure 1). It might include the 9020A, analog stimulus and measurement instruments, and the Fluke 1722A Instrument Controller, all linked via the IEEE-488 bus. The 9020A would be connected to the UUT's microprocessor socket, allowing you to control the circuitry and to run completely closed-loop tests automatically.

The 9020A sends digital signals instructing a digital-to-analog converter to output an analog voltage which the system voltmeter then measures. Or, the test system is programmed to provide an analog stimulus signal to the unit under test, while the 9020A is commanded to read the corresponding digital data from the appropriate I/O register. It's the easiest way you'll find to verify the performance of your products digital and analog circuitry.

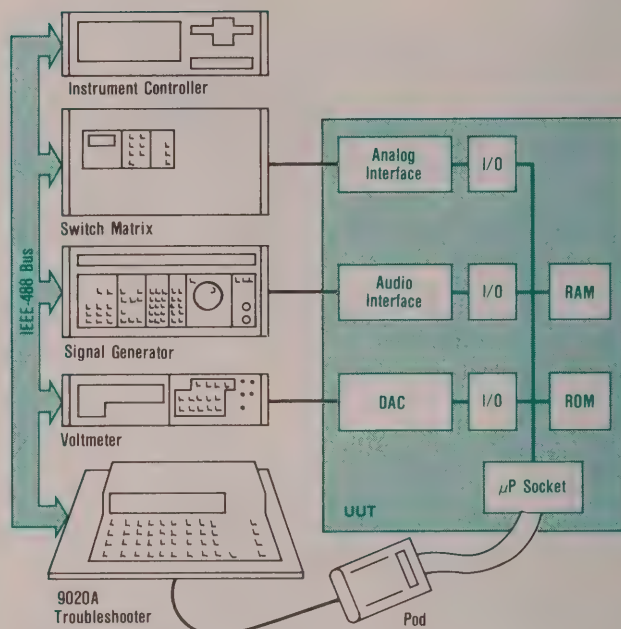


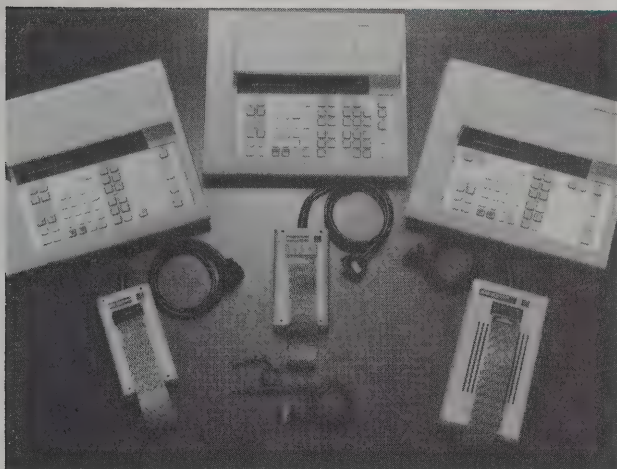
Figure 1. Block Diagram of a 9020A Test System

Another method of utilizing the 9020A is to interface it with a Personal Computer through the RS-232-C port (Figure 2). You can enter programs through the PC's keyboard and store them in the PC's memory. (The PC will remotely control the 9020A in accordance with the program running on the PC.)



## MICRO-SYSTEM TROUBLESHOOTERS

## 9000 Series



Our example demonstrates only a few of the innovative testing techniques possible with a 9020A in a custom ATE system. Whether your application is production test or depot repair, the 9020A helps you build a low-cost system that keeps automatic testing within your budget.

## Interface Pods

- 48 microprocessors supported (February 1985)
- Easy connection to unit under test
- Built-in self diagnostic tests
- Adapter kit available for other microprocessors
- Intelligent pods with built-in software
- Quick memory tests
- Quick looping Reads or Writes

The foundation of the versatility of the 9000 Series is the interface pod. Each different microprocessor system that you are troubleshooting requires an interface pod that emulates the processor. Fluke supports an extensive list of microprocessors (see the table below) and continues to develop more pods. Starting with the 9000 Series mainframe, you merely interchange pods if you wish to service more than one type of processor system. When a manufacturer builds a microprocessor there are usually several versions that operate at different clock speeds. Fluke tries to always design its pods with the processor with the fastest clock speed so that any processor in that family can be tested regardless of clock speed.

The Fluke Micro-System Troubleshooter currently can service the following microprocessors with the specified pod.

System $\mu$ P	POD Model #
1802	9000A-1802*
1804	9000A-1802*
1805	9000A-1802*
1806	9000A-1802*
6502	9000A-6502
6800	9000A-6800
68000	9000A-68000*
68010	9000A-68000*
6802	9000A-6802
6802NS	9000A-6802
6808	9000A-6802
6809	9000A-6809
6809E	9000A-6809
80186	9000A-80186*

80188	9000A-80188*
8031	9000A-8051
8032	9000A-8051*
8035	9000A-8048*
8039	9000A-8048*
8040	9000A-8048*
8041	9000A-8048*
8041A	9000A-8048*
8042	9000A-8048*
8044	9000A-8051*
8048	9000A-8048*
8049	9000A-8048*
8050	9000A-8048*
8051	9000A-8051*
8052	9000A-8051*
8080	9000A-8080
8085A	9000A-8085
8085A-2	9000A-8085
8086	9000A-8086*
8088	9000A-8088*
8344	9000A-8051*
8741A	9000A-8048*
8742	9000A-8048*
8744	9000A-8051*
8748	9000A-8048*
8749	9000A-8048*
8751	9000A-8051*
9900	9000A-9900
Z8001	9000A-Z8000*
Z8002	9000A-Z8000*
Z8003	9000A-Z8000*
Z8004	9000A-Z8000*
Z80A	9000A-Z80
Z80B	9000A-Z80/AA

\*Incorporates one or more of the Advanced Features described below

For microprocessors not found on the above list, contact your local area Fluke Sales Office or Representative for a copy of Technical Data B0156 called "User Designed Interface POD Adapters."

## Advanced Pod Features

## New Intelligent Pods

The current advances in technology have created larger and more powerful microprocessor based equipment. In order to service this growing area Fluke is manufacturing larger, more powerful pods. These new pods have a built-in, advanced software that addresses tasks specific to each newly developed microprocessor.

## Quick Memory Tests

With the advent of larger memory systems, the new pods being developed by Fluke have the capability of testing memory at a much faster rate. The 8051, 8086, 8088, Z8000, 68000, 80186, and 80188 interface pods have Quick Memory Test (QUICK RAM & QUICK ROM) built into their pod software. In addition to greatly reducing test time, the Quick Memory Tests also provide: (a) a choice of byte or word test for the 16-bit microprocessors, (b) a choice of address increment size, (c) automatic checking for inactive data bits in the Quick ROM Test, and (d) more flexibility under program control.

## Quick Looping Read or Write

The Quick Looping Read or Write function is useful for enhanced viewing of bus signals on an oscilloscope that is synchronized to the TRIGGER OUTPUT pulse (available on the troubleshooter rear panel). A signal trace may be dim when using the mainframe Looping function due to a low repetition rate. This can be remedied by using the Quick Looping function in the pod. This function will increase the repetition rate and make the trace signal more visible.



# MICRO-SYSTEM TROUBLESHOOTERS

## 9000 Series

### Specifications

**Display:** Vacuum fluorescent, able to show up to thirty-two 14-segment alphanumeric characters at one time.

**Self Test:** At each power-up. Verifies proper operation of internal RAM, ROM, clock, power supply, display, and communications with interface pod. Pod has self-test socket to verify proper operation at microprocessor plug.

**Test Speed:** Test runs at full system speed; clock is from unit under test.

**Keyboard Data Entry:** Hexadecimal, 0 through 9 and A through F.

**Mag Tape:** (9005A and 9010A only) Minicassette tape drive built in. Stores all "learned" data plus on-line generated test program with operator-prompted steps for testing outside the microprocessor-bus circuits. Up to 12K bytes, same as internal memory.

**Interface Pod:** Must match type of microprocessor used in circuits to be tested. Plugs into 9000 Series mainframe. Mainframes designed for 8-bit through 32-bit microprocessors. Pod may be plugged in backwards without damage.

**Troubleshooting Probe:** Plugs into mainframe. Operates in either stimulus or response mode. Can be synchronized to valid address or data periods on the microprocessor bus. Takes signatures, counts events, shows logic state(s) in response mode at up to full clock speed. Will inject clock-synchronized pulses or 1 kHz pulses at a specific node. Measurement thresholds are 0.8V (low), 2.4V (high). Stimulus pulses are >4V at 100 mA (high), <0.2V at 100 mA (low). Probe protected to  $\pm 30V$ .

### 9010A Automatic Functions Summary

Using a known-good system, the Learn mode locates and dimensions RAM, ROM, read/writeable I/O registers, reads ROM's and computes signatures. Learn results are stored in memory for immediate testing of the same kind of circuits — units under test (UUTs). Learned data may be saved on cassette or (with Option -001) sent to some other RS-232-C-compatible device.

The known good information about the UUT may be displayed for comparison with known architecture.

Using this data, several automated functional tests may be selected by a single keystroke. They are:

- **BUS** — Checks electrical integrity of address, data, control lines, isolates stuck nodes and adjacent-trace shorts.

- **RAM SHORT** — Checks each RAM location for ability to read and write, verifies address decoding, detects data-line shorts beyond bus buffers.

- **ROM** — Computes ROM signatures and compares with known-good signatures.

- **I/O** — Checks each I/O register identified in the known-good system for being read/writeable.

- **AUTO** — Runs all the above tests. Several minutes typically required for AUTO test.

- **RAM LONG** — Complex RAM test for isolating "soft" RAM troubles or pattern-sensitive failures.

Besides these tests, the power supply of the UUT is continually monitored for an out-of-tolerance condition. A bad clock signal in the UUT automatically gives a pod error indication.

### Troubleshooting Functions Summary

The troubleshooting keys have these functions:

- **READ** — Displays data contents of user-specified address.
- **WRITE** — Writes user-specified data to any address location.
- **WALK** — Writes automatic walking pattern to specified address.
- **RAMP** — Writes automatic binary incrementing ramp to specified location.

- **TOGGL DATA** — Pulses user-specified data bit between high and low state.

- **TOGGL ADDR** — Pulses user-specified address bit between high and low state.

- **TOGGL DATA** then STS/CTL — Pulses user-specified control bit between high and low state

The test probe control keys have these functions:

- **READ PROBE** — Display probe measurements including signatures, logic states, event counts.

- **SYNC** — Allows probe measurements or stimulus to be asynchronous or synced to address or data.

- **HIGH (Pulse)** — Activates high-going (undriven to logic "1") pulses 1 ms period, 2  $\mu s$  long.

- **LOW (Pulse)** — Activates low-going (undriven to logic "0") pulses, 1 ms period, 2  $\mu s$  long.

- **HIGH and LOW toggle** — Pulses alternate low and high.

A scope trigger-signal of about 100 mV amplitude is synchronous with the probe.

### Test-programming Functions Summary

(Not applicable to 9020A; execute only 9005A.)

For troubleshooting beyond the system kernel, through peripheral devices (PIA's, UART's, etc.) and into the unique architecture of the UUT, the following simple keystrokes by a programmer with a knowledge of the microsystem enable on-line writing and/or editing of a test program:

- **PROGM** — Opens, closes test programs for development or editing

- **EXEC** — Runs operator-selected test program

- **DISPL** — Enables generation of operator prompts; e.g. "PROBE U6 PIN 7."

- **Sequencing keys** — (IF, >, = GOTO, LABEL) for comparison, branching, looping, and labeling program steps.

- **Arithmetic keys** — Eight logical operations for arithmetic control of mainframe registers that store user-specified address and data information during program writing.

- **Editing keys** — To scroll backwards or forwards to a program step.

### Mode Control Summary

The mode control keys allow immediate control over automatic tests, programmed tests, and all troubleshooting operations:

- **STOP** — Halts current test or operation.

- **RPEAT** — One-time repeat of test or operation.

- **CONT** — Advances to next test step or continues last operation.

- **LOOP** — Continuously repeats a functional test, a programmed test step, a troubleshooting command, or loops on any fault.

- **RUN UUT** — Allows full exercise of UUT with pod microprocessor. Normally used at end of test.

### General Specifications

**Temperature:** 0°C to +50°C, operating (+10°C to +40°C for minicassette); -40°C to +70°C, non-operating (+4°C to +50°C for minicassette)

**Power:** 100, 120, 220, 240V ac  $\pm 10\%$ , 50 Hz, 60 Hz  $\pm 5\%$ , 40W maximum

**Size:** 11.5 cm H x 35.5 cm W x 30.5 cm D (4.5 in H x 14 in W x 12 in D)

**Weight:** 6 kg (11 lb) mainframe; 0.7 kg (1.5 lb) per interface pod

**Included:** Manuals, power cord, probe, probe accessories, two minicassettes. (No minicassettes with 9020A).

## MICRO-SYSTEM TROUBLESHOOTERS

9000 Series

## Models

January 1985 prices

9005A Micro-System Troubleshooter .....	\$2995
9010A Micro-System Troubleshooter .....	3995
9020A-001 Troubleshooter with RS-232-C Interface .....	4595
9020A-002 Troubleshooter with IEEE-488 Interface .....	4595

## Options

9010A-001* RS-232 Interface for 9010A or 9005A .....	395
9010A-010 Utility Tape for 9010A .....	95
9010A-020 Language Compiler compatible with Fluke 1720A and 1722A Instrument Controllers .....	495
9010A-021 Language Compiler for CP/M eight-inch, single-sided, single density diskette (IBM format) .....	495
9010A-022 Language Compiler compatible with Kay Pro II .....	495
9010A-023 Language Compiler compatible with IBM personal computer .....	495

\*Not customer installable

## Interface Pods

9000A-Z80 .....	995
9000A-Z80/AA .....	1295
9000A-Z8000* .....	1995
9000A-1802* .....	1595
9000A-6502 .....	995
9000A-6800 .....	995
9000A-6802* .....	995
9000A-6809* .....	1295
9000A-8048* .....	1995
9000A-8051* .....	1995
9000A-8080 .....	995
9000A-8085 .....	995
9000A-8086 .....	2495
9000A-8088 .....	1995
9000A-9900 .....	1995
9000A-68000* .....	1995
9000A-80186 .....	2695
9000A-80188 .....	2695

\*These pods support a family of microprocessors. See page 215 for complete list

## Accessories (Also see page 230)

9000A-200 Pod Adapter Packaging Kit .....	195
9000A-900 Transit Case .....	295
Y8007 Ten-pack of Mini-cassettes .....	150

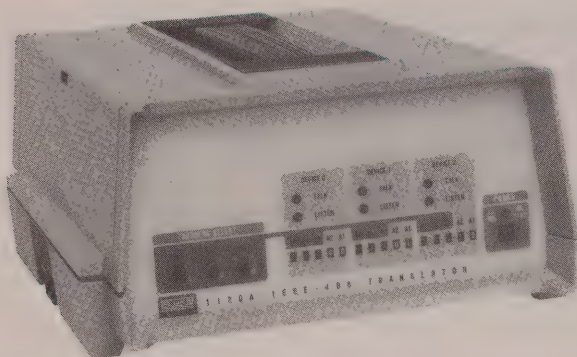
## After-Warranty Service (See page 227)

SC1-9005A, per 90-day interval .....	140
SC1-9010A, per 90-day interval .....	176
SC1-9020A, per 90-day interval .....	172



# IEEE-488 TRANSLATOR

## 1120A



1120A

### 1120A IEEE-488 Translator

Fluke's Portable Test Instrumentation (PTI) system puts low cost instruments on the IEEE bus by means of a new concept in instrumentation. The benefit is that you only pay for system capability if and when you need it. And neither size, weight, nor performance of the basic instrument is compromised for system capabilities you may never need. Instead of building interface capabilities into each low cost unit, we have designed a single instrument called the 1120A IEEE-488 Translator to do the interfacing job for you.

The 1120A is the communications link between IEEE Std 488-1978 and a variety of Fluke instruments. Operating between one or more instruments and the IEEE bus, the 1120A converts codes and signals on the bus to corresponding codes and signals compatible with the particular instrument. It passes address and control commands to an instrument or outputs data, or both, depending on the capabilities of the particular instrument being interfaced.

The 1120A is a translator for a number of Fluke instruments including universal counter/timers, communications counters, digital thermometers, frequency synthesizers, and digital voltmeters. Up to three instruments can be interfaced to the bus with a single 1120A, and as many 1120As can be used in a system as necessary.

The 1120A connects instruments to the bus through an optional data output unit in the instrument and a "personality card" in the 1120A. Each personality card is individually addressable and "transparent" to other instruments. Each corresponds to a particular Fluke instrument model and is sold as an option to that instrument or a field-installable kit. The cards simply plug in to an 1120A which provides the necessary power and microprocessor-based circuits for their operation. The 1120A personality cards, accessory cables, and instrument data output units are designed to be easily assembled by the user. As your needs change, you can quickly change cards to accommodate other Fluke instruments. Many of the instruments and cables are sold as Option -521. If so numbered, they will operate directly into a Fluke 2020A (with Option -004) or 2030A Printer without an 1120A IEEE-488 Translator.

### Building A System

Instruments that presently operate through the 1120A Translator to work in an IEEE-488 systems are: 2180A, 2190A, 6039A/AZ, 6160B, 7220A, 7250A, 7260A, 7261A, 8600A, 8810A, 8920A, 8921A, and 8922A. Ordering Option -529 with most any of those instruments will get you all the things you need to connect the instrument to an 1120A Translator. However, check the catalog pages pertaining to each instrument to be sure.

For example, if you wanted to connect both a Fluke 7261A Counter and a Fluke 8920A Digital Voltmeter to other instruments on the IEEE-488 bus you could do so by ordering an 1120A Translator and checking the option descriptions for the 7261A and 8920A. You would find you need Option 892XA-529 (for the 8920A) and Option 72XXA-529 (for the 7261A).

Optional 1-meter, 2-meter, or 4-meter cables connect the 1120A Translator to other "bus instruments."

See the instrument index in the front of this catalog for a complete listing of IEEE-compatible instruments.

### 17-4 Bit Parallel Interface

A special circuit card may be fitted into an 1120A Translator that converts it into a general purpose translator between IEEE-488 bus systems and bit parallel data systems.

One A17-4 Card handles up to 32 digital inputs and/or outputs and up to three A17-4 cards will fit in one 1120A Translator.

Any, or all, of the 32 bits may be used as input and/or output. However, these bits must be organized in groups of four or eight. BCD, binary and hexadecimal modes may be chosen, or for status outputs any single bit may be set or reset without altering other bits in the binary or hex mode.

The A17-4 can be set to continuously monitor any designated single port (8 or 4 bits). It will then request service whenever any bit of that port, which is enabled by the SRQ mask, changes to a logic True.

The A17-4 has an output strobe line which may be used to trigger or latch external devices when the data on the output lines is valid. Similar capability is built into the 2400B, 2280A, and the 1722A with Option -002.

For more information ask for Bulletin A0143C.

### Model

January 1985 prices

1120A IEEE-488 Translator .....	\$520
A17-4 Bit Parallel Interface .....	on req.

### After-Warranty Service (See page 227)

SC1-1120A, per 90-day interval .....	68
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# PC BOARD TESTERS

## Introduction

As digital and analog circuit boards are getting more complex, the challenge of high-confidence testing has escalated. Fluke has been making notable contributions to improve automatic test equipment since 1971. The demand on manufacturers to produce a quality product at a competitive price has increased the need for an improved process.

Fluke's family of functional testers and manufacturing defects analyzers provide a low cost solution, not only for the manufacturing process, but the repair cycle as well.

To improve your manufacturing process you must start at the beginning. Utilization of the 3200B Manufacturing Defects Analyzer for testing your bare boards at incoming inspection will insure you are loading fault free PCBs. This same system can and should also be used to test all PCBs after the insertion

of components. Through this process you have now just eliminated the majority of possible faults that can occur on a printed circuit board.

The Digital/ Analog Functional Test System will eliminate the remainder of the faults, which are those troublesome, hard to find dynamic faults. The functional systems use signature analysis and comparison testing to throw literally millions of bits and patterns at the board under test. Using this method you can establish the entire operational integrity of the board.

By using the Fluke Solution you can obtain up to a 98% confidence level for board testing, whether in your manufacturing or repair facilities.

## Selection Guide

	Ref Bd Test	Single Bd Test	Analog Test	Ads	Auto Track	GFI	AFE	Digital Test	Ref Page	Base Price*
3010A		X				X		X		\$23K
3040A-1	X	X	X		X	X	X	X		\$80K
3050B	X	X	X	X	X	X	X	X		\$100K
	Auto Learn	R.L.C. Measure	Pin Verify	RS-232-C	Multi Site	BB	LB	BP		
3200B	X	X	X	X	X	X	X	X		\$32K

\*Approximate January 1985 U.S. prices presented for comparison and subject to change.



## The ATE Environment

Companies purchase Automatic Test Equipment (ATE) to reduce human error and to increase speed and thoroughness of testing. Additional ATE systems can find the dynamic faults and develop statistical data that is otherwise difficult and time consuming for even the most experienced technician.

ATE systems are purchased to locate six types of board faults:

- Opens
- Shorts
- Leakage
- Wrong components
- Missing components
- Improper component orientation

If 100 boards were tested, on the average, 33 of them would be found to be faulty in some way with the faults appearing in the following proportion:

The types of PCB faults listed above include those which occur most often. This is how a typical fault breakdown looks:

- 5% are bare-board faults
- 45% are manufacturing opens and shorts
- 20% are missing or wrong parts
- 10% are backwards parts
- 10% are bad components
- 10% are interactive functional failures

The Fluke 3200B can be used to find many of these faults. It fits well into incoming inspection, where it can test bareboards for manufacturing defects, or after board stuffing and wave soldering, it can locate the remainder of your non-functional manufacturing defects. The 3050B Functional Test System can then be used to locate dynamic faults and interactive failures. Thus, the combination of the 3200B and the 3050B test systems serve to provide you with a total ATE solution for your manufacturing process.

The typical PCB repair depot has a different problem to address. No longer are we dealing with manufacturing defects because theoretically, these returned PCBs did, at one time, function properly. This means they have dead or marginal components, or the most difficult to find timing problems. Inexpensive fixturing and moderately easy programming makes the Fluke Functional Systems ideal for this situation. Even a repair facility with a fairly large number of different low volume printed circuit boards can benefit greatly from a Fluke Functional System.

## Support

Fluke offers a complete support package to insure you successful use of your Fluke systems.

We not only support you with training and applications assistance, but a lease program for those who want to conserve capital. Training programs are conducted at our Everett, Washington offices as well as at your facility. Applications assistance is provided from your local sales area with technical backup from our highly qualified factory personnel.

Warranty and installation are also provided from your local service center, giving rapid response to any problem that should arise. We understand the need for maximum up-time for your system. We strive for 98% up-time and supported through our module exchange, maintenance contract, and technical support programs.

Let the Fluke Solution solve your ATE problems and put you back in control of your manufacturing or repair process.

## PC BOARD TESTERS

3010A/3040A-1



3010A

**3010A Logictester**

- Portable benchtop tester
- Simplified programming
- High speed/one pass testing
- Walk-back diagnostics

**Portable Benchtop Tester**

The 3010A is a self-contained portable logictester capable of functionally testing moderately complex printed circuit boards. It simplifies programming by providing a large array of stimulus signals with various duty cycles. Using pushbutton inputs, programming and editing can be performed on-line; assemblers, compilers, and tapes are eliminated.

**Simplified Programming**

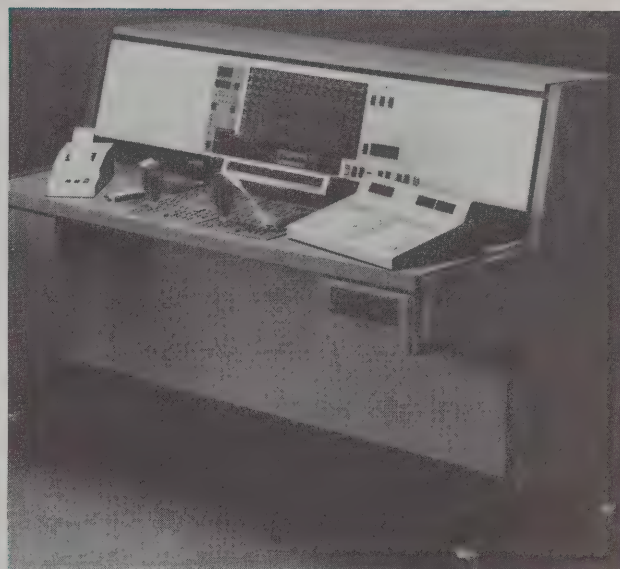
The large array of automatic, algorithmically generated stimulus patterns eliminate the high cost and complexity of programming required to create input stimulus. Programs normally taking weeks can now be generated in a matter of hours, by simply developing a test plan which consists of selecting the appropriate stimulus algorithm for each input.

**High Speed/One Pass Testing**

High speed testing at rates up to 4 MHz can be accomplished, as well as one-shot and continuous pulse width measurement. An Output Count Integrator (OCI) logically combines the activity of all I/O pins into a single signature, for one pass go-no-go tests.

**Walk-Back Diagnostics**

When a failed board is to be diagnosed, the signatures of 8-pin subgroups are checked until a defective group count is noted. Nodal transition counts of the ICs in the signal path are back-tracked to the point where inputs to an IC are normal and the output fails. This is the defective node. Walk-back diagnostics using nodal signatures, listed on either the schematic or a from-to list, allow rapid troubleshooting to a faulty node.



3040A-1

**3040A-1 Digital/Analog Test System**

- Reference board testing
- Single board test
- Stored and automatic sequence programming
- Automatic fault emulator (AFE)
- Multimode diagnostics
- Analog testing
- Off-line programming station

**Reference Board Testing**

Reference board testing minimizes test programming by eliminating the need for the test engineer to provide the response, or predict data for the unit under test. It provides the most accurate response data of any other functional test method. Reference board testing eliminates the need for large memory and time consuming IC modeling.

**Single Board Test**

The need to store known-good reference boards is eliminated by the single board test feature. It is a signature-based diagnostic program for fault finding on a single unit under test. The system generates a composite signature from all the board-edge pins. A faulty bit stream on any board-edge pin, then results in a faulty signature and a failed test.

**Stored and Automatic Sequence Programming**

Stored Sequences are the user-defined patterns which can be expressed as symbols with hex masking to define output data or as individual ranges of I/O channels. Auto Sequences are pseudo-random, gray encoded automatic patterns consisting of clocks, pulses, and data. Automatic patterns may be generated at a rate up to 4.99 MHz, 2 MHz when stored sequences are used. Stored patterns are used to gain control of the unit under test functions and automatic patterns are used to exercise those functions.



# PC BOARD TESTERS

3040A-1

## Automatic Fault Emulator (AFE)

AFE tests the comprehensiveness of a test program using one of five different classes of faults. Faster and more accurate than a hypothetically generated fault simulation. At the end of the fault insertion and activity monitoring process a statistical summary is printed, which lists the percentage of fault detection and activity.

### Fault Types:



Stuck Low



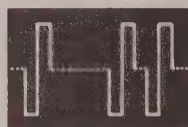
High-Low



Intermittent Low



Intermittent High



Intermittent High Low

## Multimode Diagnostics

Autotrack® offers optional guided clip and probe algorithms for tracking defects and breaking loops. The operator's probing is guided by messages displayed on a 30 character alphanumeric display. Autotrack® keeps a record of where it has been as it is tracking to resolve loop faults. A printer lists the probe tracking sequence and diagnostic statements, then prints the nodal fault location. Even dynamic circuits like microprocessors, which defy static analysis, can be easily diagnosed.

## Analog Testing

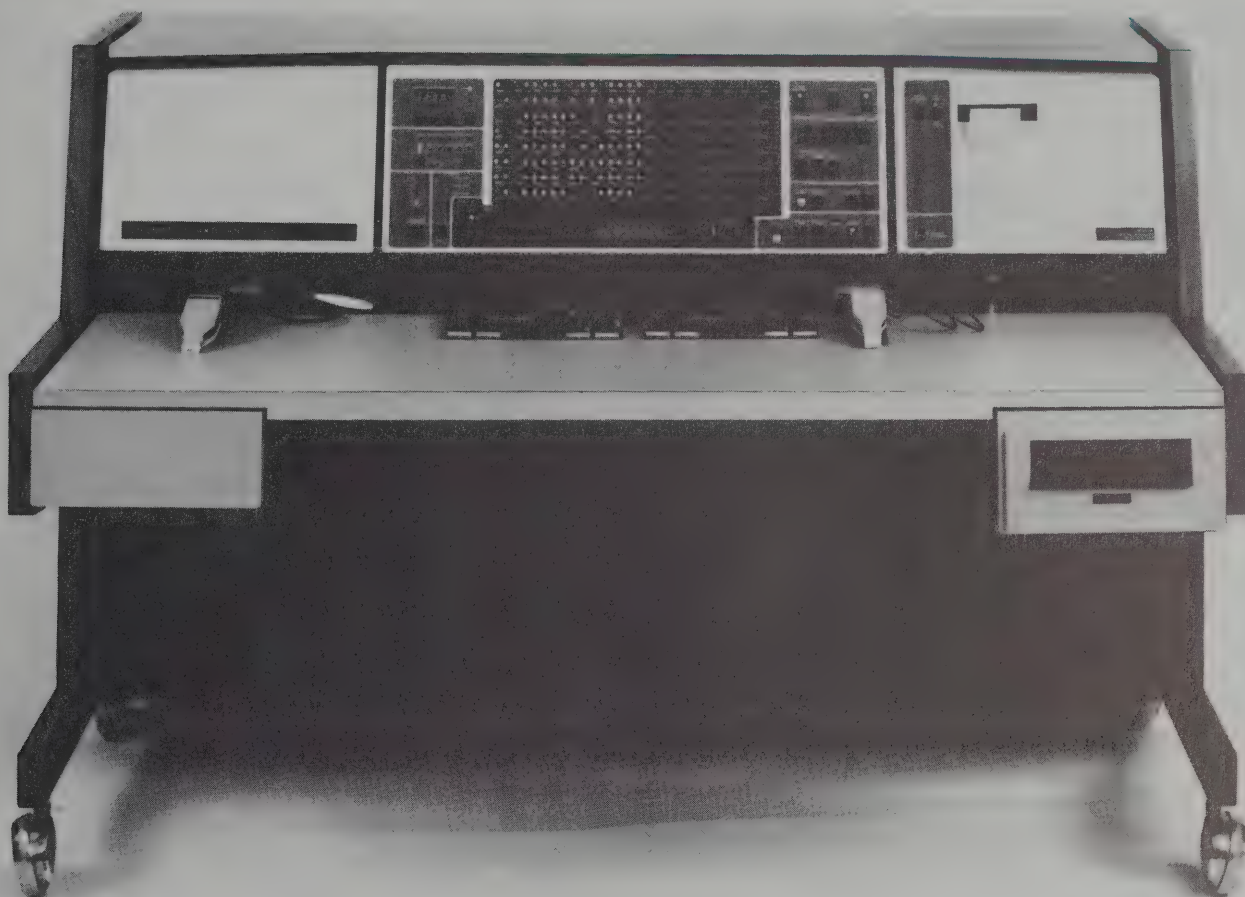
Complex Waveform Conformance (CWC) available with the analog option provides up to 32 channels of analog testing capability. Both analog and digital signals, on the same board, can be tested in parallel, in real time.

## 3041A-1 Off-Line Programming Station

An off-line program generation and documentation station for fast, efficient preparation of test and diagnostic programs. The system's prompting editors guide the test engineer through program entry without disturbing program continuity. The console houses a full ASCII keyboard, CRT display, dual floppy disk drives, and a universal RS-232-C communication capability that will interface with a variety of printers to provide permanent program documentation.

## PC BOARD TESTERS

3050B



3050B

## 3050B Digital/Analog Functional Test System

- Automatic diagnostics software (ADS)
- Automatic fault emulation (AFE)
- Reference board testing
- Analog comparison
- Single board test
- Analog test station IEEE-488
- Offline programming station
- 1780A InfoTouch® Display

## Automatic Diagnostics Software (ADS)

This feature provides completely automated troubleshooting of digital circuitry including unidirectional and bidirectional circuitry, as well as loops, and initialization problems. ADS can also interface to the Test Management System (TMS) language providing analog diagnostic capability.

## Analog Comparison

Fast implementation for testing analog waveforms is provided by the analog comparison method. The analog comparators check for waveform differences between the reference board and unit under test, using program defined voltage tolerances. This allows for easy detection of gain, phase, and shape errors in an analog waveform.

## Reference Board Testing

Reference board testing minimizes test programming by eliminating the need for the test engineer to provide the response or to predict data for the unit under test. It provides the most accurate response data of any functional test method. Reference board testing eliminates the need for large memory and time consuming IC modeling.



# PC BOARD TESTERS

## 3050B

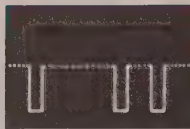
### Fault Types:



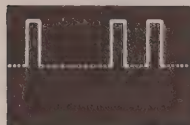
Stuck Low



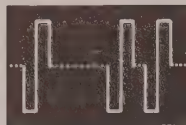
High-Low



Intermittent Low



Intermittent High



Intermittent High Low

### Single Board Test

The Single Board Test feature eliminates the need to store known good reference boards. It is a signature-based diagnostic program for fault finding on a single unit under test. The system generates a composite signature from all the board-edge pins. A faulty bit stream on any board-edge pin, then results in a faulty signature and failed test.

### Automatic Fault Emulation (AFE)

AFE tests the comprehensiveness of a test program using one of five different classes of faults. It is faster and more accurate than a hypothetically generated fault simulation. At the end of the fault insertion and activity monitoring process a statistical summary is printed, which lists the percentage of fault detection and activity.

### 3053A Analog Instrumentation Module

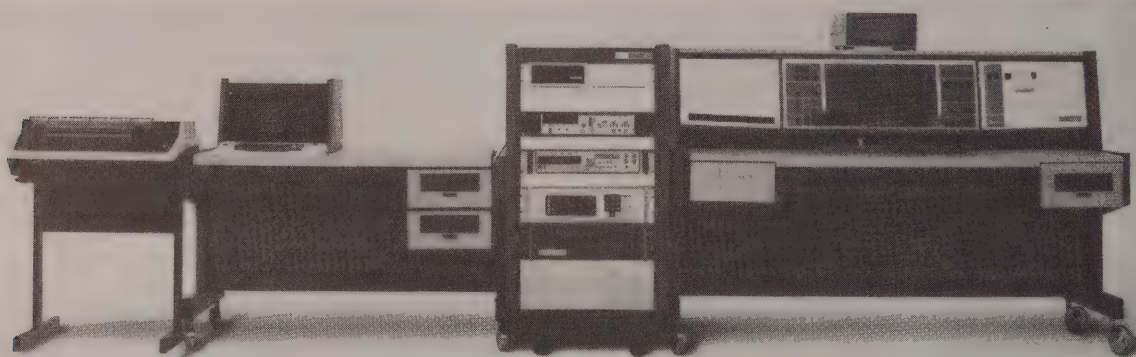
Another way to test analog circuits is using the 3053A with its rack of IEEE-488 compatible instruments. The result is increased voltage and frequency measurement capability over the analog comparator method: voltages of  $\pm 50V$  and frequencies ranges to 10 MHz. This module provides semi-automated diagnostics to a stage.

### 3051B Off-Line Programming Station

An off-line program generation and documentation station is available for fast, efficient preparation of test and diagnostic programs. The system's prompting editors guide the test engineer through program entry without disturbing program continuity. It also supports versatile RS-232-C communications for data transfer to the 3050B and to external computer systems.

### 1780A InfoTouch® Display

This feature provides a means for the test programmer to increase the operator interaction capabilities of the 3050B. It can be used to provide test set-up instructions, test procedures, or allow inputs for data logging information, such as date, operator name, unit under test serial number, etc.



#### Printer

Fast RS-232-compatible printer for permanent program documentation

#### 3051B

Offline Programming Station with two floppy disk drive units, keyboard, and terminal. System's prompting editors guide test engineer

#### 3053A

Test station of analog stimulus and measurement instruments. RS-232 and IEEE-488 interfaces. Programming uses adapted ATLAS language.

#### 3050B

Test console with clips and probes for both reference board and board under test. Reference board eliminates need for large memory, time-consuming IC modeling. A 35-column printer provides hard copy of test analysis.

## PC BOARD TESTERS

3200B



3200B

## 3200B Manufacturing Defects Analyzer

- High speed testing of bare and loaded boards and backplanes
- Multisite testing
- High test point count
- Auto-learn programming
- Communications interface
- Fixturing flexibility
- Pin verification
- Semiconductor junction testing on loaded PCBs
- Resistance measurements for resistor values and component orientation testing
- Program up/down load to CAD/CAM

## High Efficiency

The 3200B Manufacturing Defects Analyzer is designed to increase the effectiveness and efficiency of test operations. It does this by testing both bare and loaded boards, as well as backplanes, card cages, harnesses and cables for shorts and opens and other types of

manufacturing defects such as missing, reversed, wrong and dead components.

The 3200B can identify 80% of the possible loaded board faults. With its high fault coverage, low cost and high testing speed, the 3200A is ideally suited for use as a stand-alone tester, or as a means of off-loading existing in-circuit or functional testers. By using it first, the remaining 20%, the subtle out of tolerance, and functionally-related faults can be identified by the more sophisticated and expensive functional or in-circuit tester.

## Quick Start-Up

The 3200B's Auto Learn feature permits testing to begin within minutes after a board test fixture becomes available. By learning the connectivity and impedance characteristics of a known-good circuit board, the 3200B can be testing product immediately. User-defined nomenclature for improved diagnostic messages can be added in just a few hours. A fully enhanced program capable of diagnosing all classes of manufacturing defects typically requires two to three days.

## Multi-Site/High Point Count

The multi-site capability permits testing at two sites for loaded boards and up to four sites for any combination of bare boards or backplane testing. Testing capacity can be significantly increased at a small increase in cost. Up to 65,535 test points can be distributed



# PC BOARD TESTERS

## 3200B

among the four test stations.

Each test station may use either the same program or a different program and is equipped with its own Remote Operator Control unit. The unit features a 35-column fault reporting printer, pass-fail lamps, a data-entry keyboard with four-digit display, and a cycle-test key for easy fixture debugging.

### Off-Line Programming

The 3200B includes an off-line programming station which permits concurrent programming and testing activities. Testing can be in progress on all test stations while the program is editing or developing test programs. The programming station consists of a video display, keyboard and microcomputer with dual eight-inch floppy disk drives. The disks provide 2.5 megabytes of storage, half of which is available for user test program storage.

### Fixturing Flexibility

A variety of fixturing solutions for different applications are available from Fluke. In addition, the 3200B can be interfaced to most manufacturer's fixturing.

### Pin Verification

Before loaded board testing, the 3200B can perform pin verification checks. The tester verifies that the pins are actually making board contact prior to starting the test. Faulty pin contacts are reported to prevent an invalid diagnostic.

### Specifications

**Test Points:** Maximum of 65,536 test points for each 3200B system; bed-of-nails switchboard with 128 points

**Interface Cabling:** Daisy chained; one cable for each 2048 test-point array

**Dual Continuity Thresholds:** Loaded boards: short, 10 $\Omega$ -10 k $\Omega$ , programmable; open, 1 k $\Omega$ -10 k $\Omega$ , programmable. Bare boards, backplanes: short, 10 $\Omega$ -10 k $\Omega$ , programmable; open, 1 k $\Omega$ -100 k $\Omega$ , programmable

**Test Stimulus Voltage For Continuity:** Loaded PCBs, 300 mV; bare PCBs 8V; backplanes, cables, 8V

**Test Sites:** Up to a maximum of four test sites share the test processor. Each test site equipped with Remote Operator Control (ROC) panel with independent controls and printer

**Junction Tests:** Two-point programmable from 250 mV to 8V, with tolerance range; for diodes, transistors and ICs; resistance measurement; programmable 10 $\Omega$ -100 k $\Omega$ , with tolerance range

**Programming:** Automatically learns continuity patterns from known good UUT; manual entry via off-line programming station; download from CAD/CAM

**Auto Learn Time:** Approximately 2 minutes for 1000 test points (typical)

**Remote Operator Control ROC Panel:** One per test site

**Printer:** 35-column impact type. Upper/lower case ASCII character. Print speed 60 characters/second

**Keylock:** Protects test programs from unauthorized modification

**Displays:** Four-digit LCD for entry of numeric data from key pad

**Controls:** Learn, bare board, loaded board, backplane. Set dual HI/LO threshold limits. Operator ID number, day/month. Test/continue, job number. Print first fail, print statistics. Clear statistics, print program listing. Enter data, save auto-learn data file on UUT. Reset, abort. Paper advance

**Indicators:** Test, reset, halt, power, on/off, pass fail

**Other:** External input connection for installation of foot switch or Assign Probe. External RS-232-C output port

**Statistics:** Quantity of UUTs tested and quantity and percent passed

**UUT Nomenclature:** Up to 20 alphanumeric characters per test point

**CRT Terminal:** 14", 80 columns x 24 lines, upper/lower case ASCII characters, 7 x 9 character font

**Program Storage:** Dual disk drives, 1.25 megabyte storage per drive.

Multiple programs per diskette with file directory

**Assign Probe:** Single-point probe for convenient UUT product nomenclature identification

**External RS-232-C:** Communications port for up/down loading from CAD and external computer systems. Maximum baud rate, 9600 asynchronous

**132-Column Printer (optional):** Model 3058A impact printer; 160 characters/second

# PRODUCT SUPPORT & SERVICES

## Introduction

At Fluke, we know that successful applications result not only from superior equipment but also from effective planning before implementation, training and consultation during implementation, and responsive maintenance and support in the long term.

Listed below and described on the following pages are the range of support and services that Fluke offers.

To discuss how we can help bring your applications solutions to full productivity quickly and maintain that productivity for many years contact your nearest Fluke Technical Center, Sales Office, or Representative.

## Selection Guide

Support or Service	U.S.A.	Other Countries
Product Availability Product Specification Application Assistance	Your Sales Office (See page 243) or phone either (800) 426-0361* or (206) 356-5400	Your Fluke Representative (See page 244 or 246) WU Telex: 152385 TRT Telex: 185-103 Phone: (206) 356-5500
Consultation Software Development Site Evaluation Installation Application Training	Your Sales Office (See page 243)	Your Fluke Representative (See page 246 or 247)
Repair/Calibration Training Repair/Calibration Service Repair/Calibration Assistance Service Agreements Module Exchange	Your Technical Center (See page 246)	Your Service Representative (See page 246)
Replacement Parts Instruction Manuals	(800) 526-4731** or (206) 356-5774 John Fluke Mfg. Co., Inc. P.O. Box C9090 Everett, WA 98206 Attention: Parts Dept. M/S 86	Your Service Representative (See page 246)

\*8 a.m. to 4:30 p.m. Pacific time

\*\*5 a.m. to 4 p.m. Pacific time



# PRODUCT SUPPORT & SERVICES

## Assistance and Consulting

- Applications assistance and consulting
- Hardware assistance and consulting
- Software assistance and consulting
- Site evaluation and installation consulting
- Third-party support and consulting

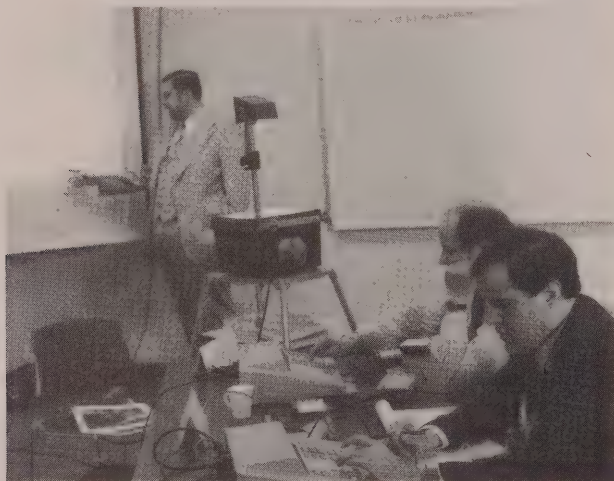
When Fluke electronic test and measurement equipment is used in a systems application the systems builder may wish to request additional support from the Fluke organization. This support could be as easy as a telephone call or as comprehensive as on-site consultation. The Applications Support Group can provide a full range of customer assistance and support for all Fluke hardware and applications.

## Customer Training

- Maintenance training
- Applications training
- Product training
- Technology seminars
- Special customer training packages

Training is a key element in our Customer Support program, providing the essential transfer of knowledge necessary to insure successful utilization and maintenance of Fluke products.

The Training Group develops and implements both regularly scheduled and custom-tailored training courses to meet a wide range of customer needs. To discuss your special Training needs, or to obtain our 1985 Training Course schedules, please contact your nearest Fluke Sales office or International Representative.



## Repair and Calibration Services

- 90-day warranty of complete unit
- Installation of product improvements
- Full N.B.S. traceable calibration and/or alignment
- Standard pricing for most models
- Documented quality assurance program
- Compliance with MIL-STD-45662 and nuclear industry standards
- Special calibration data available

Each Fluke Technical Center is equipped with the necessary instruments, standards, procedures, and personnel to maintain Fluke products at peak performance. The procedures and documentation comply with MIL-STD-45662 and Nuclear Regulatory Commission requirements, assuring accuracy traceable to the National Bureau of Standards. Proper use of measurement standards is carefully and continually monitored through a corporate Controlled Audit Program.

The Fluke Standard Price Program establishes a fixed charge for calibration and/or repair for each type of instrument. The price for calibration and/or repair includes all labor and material required.

These standard prices, which are based on historical averages for time and material, help you determine service costs in advance and avoid the potentially critical delay of quotation and approval procedures. Naturally, some units may have to be excluded from the program because of age or abuse. In such cases you will be advised and, if you approve, charged on the basis of the actual labor and parts required.

For more details and a current price list on the Standard Price Program, contact your nearest Fluke Sales Office or International Representative.

## Service Agreements

- Fixed maintenance cost. You can budget accurately each year
- Prioritized service
- Shorter repair cycle
- Reduced parts inventory
- Lower maintenance training costs
- Less demand on your technical personnel and resources

Service agreements are a cost-effective way of maintaining your Fluke instruments at pre-determined costs.

The Fluke Customer Support Group offers three types of Service Agreements:

**Standard Service Agreements — On Site.** On-site Service Agreements on selected Fluke products are available which provide services conducted on your premises. These agreements normally cover a one year period, and include parts, labor, and travel costs. There are no inspection costs when purchased prior to warranty expiration or prior to renewal of a previous agreement.

On-site agreements offer priority attention, with a typical response time of 1 day or less. The cost for this agreement depends on the type of instrument or system, the distance to the nearest Fluke Technical Center, and whether the agreement period includes the product warranty period. For your convenience, monthly, quarterly or yearly payment intervals are available.

**Standard Service Agreements — Technical Center.** This Repair Service Agreement provides warranty-like support performed at your nearest Fluke Technical Center. The agreement provides labor, parts, recalibration and return surface transportation for all covered Fluke products which fail through normal use during the agreement period. Agreements can be purchased without pre-agreement inspection costs if the product is still under new product warranty, or within 90 days of out-of-warranty service performed by a Fluke Technical Center.

A discount of 10% from the normal cost of the Standard Service Agreement will be given if the agreement is purchased with the instrument, and will commence at the warranty expiration date. The annual cost of Standard Service Agreements for individual instruments is shown on the catalog page describing that instrument.

**Calibration Service Agreements.** Calibration Service Agreements are available to provide scheduled calibration services at intervals you specify. This agreement can be combined with a Repair Service Agreement to satisfy your complete maintenance needs. Prices vary with model and desired calibration interval. Your local Fluke Sales Office or International Representative can provide complete information on agreements of this type.

## Replacement Parts

- Components that meet Fluke specifications standards
- Automatic notice of improved replacement types
- 90-day warranty
- Toll free parts order line (800) 526-4731\*
- Recommended spare parts and kits

Availability of replacement parts is a key element in providing quick turn-around and product support for customers who perform their own maintenance. By providing quality parts and responsive support, the Customer Support Group will help return your Fluke instrument to peak performance.

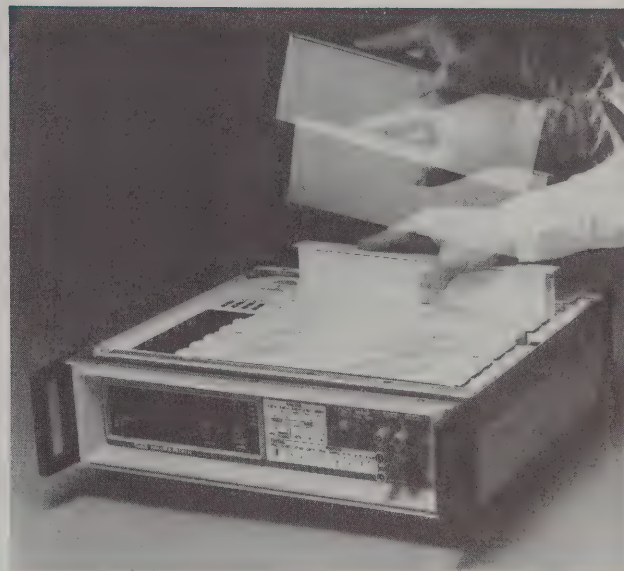
To support this service, an extensive inventory of repair parts is maintained by the Parts Department in Everett, Washington. From U.S. locations, you may place your orders directly to the Everett Parts Department by calling our toll-free number, (800) 526-4731.\* From locations outside the U.S., place your parts order with your nearest International Representative, who will expedite processing or fill your order from local inventory.

When ordering, please identify parts by the Fluke six-digit part number and description as shown in the instrument manual and, if possible, by the schematic diagram circuit reference number. The model number and serial number of the instrument will also help us supply the correct parts.

In some cases parts must be ordered in matched sets in order to maintain the specified accuracy and performance of the instrument after repair. Check the parts list and diagrams for footnotes containing special parts ordering instructions.

Recommended Spare Parts Lists or Spare Parts Kits are also available for most Fluke products.

\*Hours: 5 a.m. to 4 p.m. Pacific time. Address: Parts Dept., M/S 86, John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, WA 98206



## Module Exchange Program

- Available for most modular products
- 24-hour delivery to most U.S. locations
- Minimum downtime for critical applications
- Reduced maintenance personnel training requirements
- Takes full advantage of product diagnostics
- 90-day warranty

Many Fluke instruments are modular in design and can be serviced most effectively by exchanging a defective module.

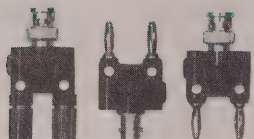
The Module Exchange Program allows you to obtain an exchange module quickly and economically. When using this program, you need only identify the defective module, which simplifies your troubleshooting procedures and reduces your training and skill requirements for maintenance personnel. Self-diagnostics built into many Fluke instruments further simplify the process of identifying the faulty module.

Once a defective module is identified, your local Fluke Technical Center (see page 246 for locations) will place your order with the Module Exchange Center located in Everett, Washington. The replacement module will be sent directly to you via overnight air carrier. A similar program is offered to customers in countries outside the U.S.

Please contact your Technical Center or International Representative for a list of Fluke products which are supported by the Module Exchange Program, and detailed information on exchanging defective modules.



# ACCESSORIES



Y9109 Y9108 Y9113

## BNC-Banana Adapters

BNC-to-banana adapters permit interconnection between equipment having BNC plugs or jacks and equipment with double banana plugs or jacks.\*

*\*These adapters and exposed metal connectors should not be used for floating measurements that are greater than 30V ac, 42V peak or 60V dc above earth ground.*

Y9109 BNC Plug to Binding Posts

Y9108 BNC Jack to Double Banana Plugs

Y9113 BNC Plug to Double Banana Plugs



Y9115

Y9114

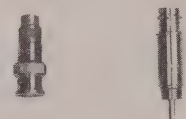
## Phone Adapters

Adapters permit interconnection between equipment with phone plugs and equipment with BNC connectors.\*

*\*These adapters and exposed metal connectors should not be used for floating measurements that are greater than 30V ac, 42V peak or 60V dc above earth ground.*

Y9115 BNC Plug to Phone Jack

Y9114 BNC Jack to Phone Plug



Y9117

Y9116

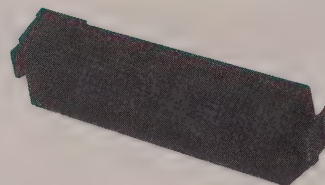
## Phono Adapters

Adapters allow interconnection between equipment having phono connectors and BNC connectors.\*

*\*These adapters and exposed metal connectors should not be used for floating measurements that are greater than 30V ac, 42V peak or 60V dc above earth ground.*

Y9117 Phono Jack to BNC Plug

Y9116 BNC Jack to Phono Plug

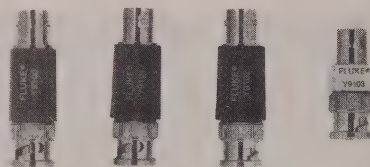


M00-100-714

## M00-100-714 Panel Protectors

A front panel protector is a molded plastic, snap-on accessory which fits over the front panel of a DMM, counter, etc. The cover provides protection for the front panel controls, and is useful for storing or transporting the instrument.

M00-100-714 is designed to fit the 8000A and 8600A DMM, and the 1900A, 1910A, 1911A, 1912A Counters. M03-203-700 is designed to fit the 515A Calibrator and the discontinued 8200A DMM.



Y9100

Y9101

Y9102

Y9103

## BNC 50-Ohm Attenuators, etc.

BNC 50-ohm, 2-watt attenuators for use with VHF and UHF instruments:

Y9100 6 dB Attenuator

Y9101 14 dB Attenuator

Y9102 20 dB Attenuator

Y9103 50-ohm feedthrough termination



Y9107

Y9110

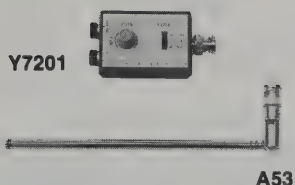
Y9106

## BNC Connectors

Y9107 BNC "T"

Y9110 BNC Jack for printed circuit boards

Y9106 BNC "T"



## Y7201 Attenuator/Filter

The Y7201 is a combination variable attenuator and selectable low pass filter which can be used for input signal conditioning on all Fluke counters.

**Input Impedance:** 47 k $\Omega$

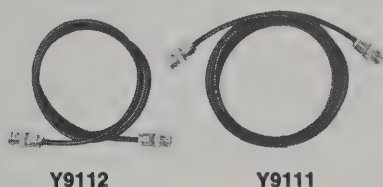
**Attenuation Range:**  $\pm 5$  to  $\pm 100$ , continuously adjustable

**Low Pass Filter:** 1 kHz, 20 kHz, or 100 kHz switch-selectable

**Maximum Input:** 30V

## A53 Telescopic Whip Antenna

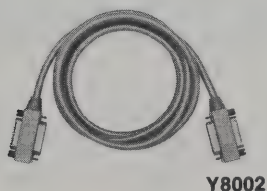
Telescopic Whip Antenna connects to input of all counters. Uses swivel BNC connector. Permits measurements without direct cable connections whenever input signal strength is sufficient.



## 50 $\Omega$ BNC Coaxial Cables

RG-58 C/U coaxial cables with BNC connectors (plugs) on each end are available in two lengths:

**Y9111** 0.93m (3 ft), **Y9112** 1.85m (6 ft)\*



## IEEE-488-Compatible Cables

A series of cables in three lengths are used to connect instruments to each other and to the IEEE-488 Bus. Each cable end has both a plug and a jack and are shielded.

**Y8021** Shielded Cable, 1m (39.4 in)

**Y8022** Shielded Cable, 2m (78.8 in)

**Y8023** Shielded Cable, 4m (13 ft)

\*These adapters and exposed metal connectors should not be used for floating measurements that are greater than 30V ac, 42V peak or 60V dc above earth ground.



## RS-232 Cables

These cables are to connect instrument controllers, terminas, modems, printers, etc. to other similar equipment compatible with EIA Standard RS-232-C.

**Y1702** 2m (6.3 ft) Null Modem Cable

**Y1703** 4m (13 ft) Null Modem Cable

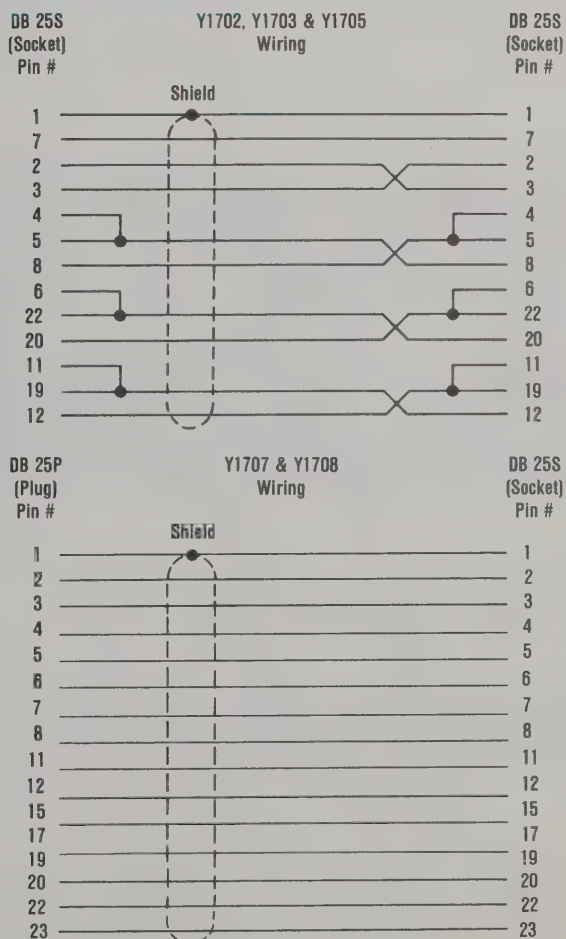
**Y1705** 25 cm (1 ft) Null Modem Cable

**Y1707** 2m (6.56 ft) Interface Cable

**Y1708** 10m (32.8 ft) Interface Cable

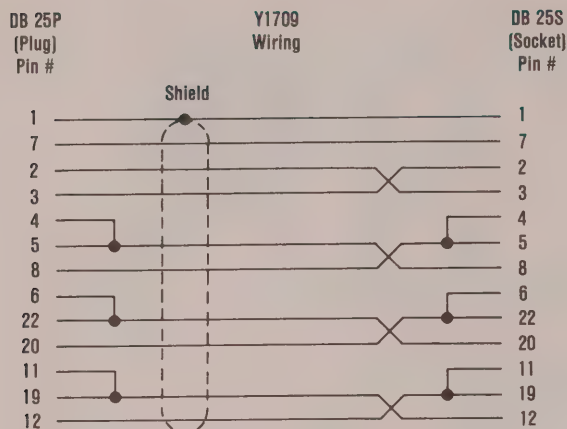
**Y1709** 1m (3.28 ft) Printer Cable

## RS-232 Cable Wiring





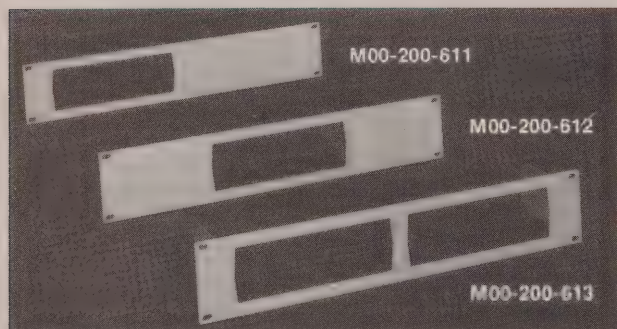
# ACCESSORIES



## Rack-Width Rack Adapters

Fluke bench/systems instruments are designed to be easily mounted in a standard 19-inch rack cabinet. Some have rack-mount panels and some need rack adapters. When adapters are required they are listed with the instrument — among its recommended accessories.

## Portable Instrument Rack Adapters



## Multimeter Rack Adapters, 3½" High

8010A M00-200-611, M00-200-612, and M00-200-613  
8000A, 8012A, 8050A, 8600A. Same as for 8010A  
8804A Y8834 and Y8835

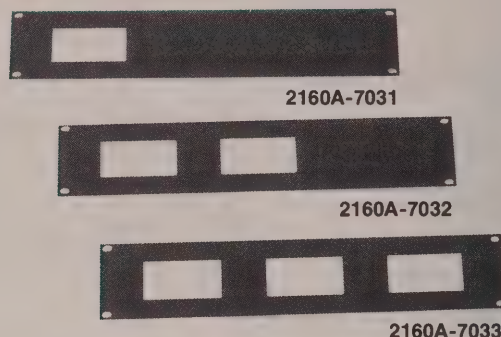
## Counter Rack Adapters, 3½" High

1900A M00-200-611, M00-200-612, and M00-200-613  
1910A, 1911A, 1912A Same as for 1900A

## Thermometer Rack Adapters, 3½" High

2165A M00-200-611, M00-200-612, and M00-200-613  
2166A, 2168A, 2175A, 2176A Same as for 2165A

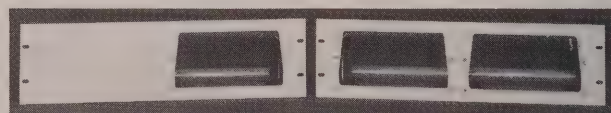
## Panel-Mount Thermometer Adapters



Either the 2160A or the 2170A Thermometer may be mounted in these rack-width panels that are 3½ inches high. Also, the 2161A Multipoint Selector and 2162A Digital Comparator will fit the panel openings.

## PTI-Style Instrument Adapters

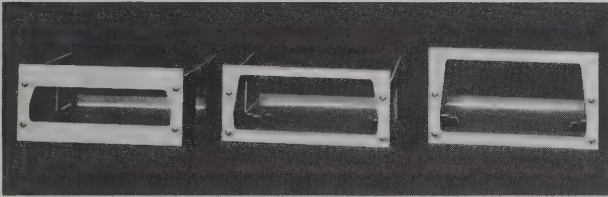
Rack adapters for the 2180- and 2190-Series Thermometers, 7200 Series Counters, 8920 Series DVMs, and other Fluke products in PTI cases look like those shown in the picture except for the size of the opening or height of the panel.



PTI Case Style	Panel Opening		Rack Panel Size	
	Single	Double	Height	Width
Style A	Y2010	Y2011	3½ in (89 mm)	19 in (483 mm)
Style B	Y2012	Y2013	5¼ in (133 mm)	
Style C	Y2014	Y2015	7 in (177.8 mm)	
Style D	Y2016	Y2017	5¼ in (133 mm)	
Style A + C	—	Y2027	5¼ in (133 mm)	

## PTI-Style Instrument Panel Adapters

Fluke instruments in PTI-style cases may be mounted behind your own panel through a standard size panel opening by using one of the adapters identified below.



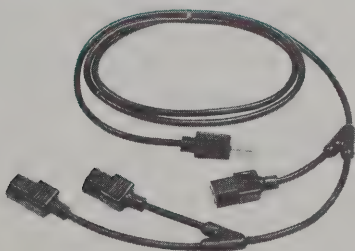
PTI Case Style	Adapter Number	Panel-Mount Adapters			
		Panel Cutout		Bezel Size	
		Height	Width	Height	Width
Style A	Y2018	92 mm (3.62 in)	186 mm (7.32 in)	97 mm (3.82 in)	214 mm (8.43 in)
Style B	Y2019	92 mm (3.62 in)		97 mm (3.82 in)	
Style C	Y2020	*		122 mm (4.80 in)	
Style D	Y2021	138 mm (5.43 in)		145 mm (5.70 in)	

\* Any dimension from 96mm to 116mm. Not Standard. Each kit fastens to a panel with four machine screws. The bezel fits over the front of the panel cutout and the screws hold the bezel and rear (instrument) support bracket to the panel.

## PTI-Style Instruments

PTI Instruments & Accessories	PTI Case Style			
	A	B	C	D
1120A			•	
2020A, 2030A, 2300A				•
2180A, 2189A, 2190A			•	
Y2000, Y2001	•		•	
Y2002		•	•	
Y2003, Y2009		•	•	
7220A, 7250A, 7260A, 7261A			•	
8860A				•
8920A, 8921A, 8922A			•	
Y5020				•
Y2023			•	

## Y2024 3-Module Power Cord



Three 3-wire receptacles for powering two or three PTI-style instruments from one power outlet.

## PTI Case Dimensions

Style	Height	Width	Depth
A	57 mm (2.25 in)	205 mm (8.05 in)	326 mm (12.85 in)
B	82 mm (3.23 in)		
C	105 mm (4.13 in)		
D	128 mm (5.03 in)		

## Models

January 1985 prices

* A53 Telescopic Whip Antenna	\$25
* A81-115 115V Input (U.S. plug)	20
* A81-230 230V Input (European plug)	20
* A81-100 100V Input (U.S. plug)	20
Y1703 4m (13 ft) Null Modem Cable	150
Y1705 25 cm (1 ft) Null Modem Cable	75
Y1707 2m (6.56 ft) Interface Cable	125
Y1708 10m (32.8 ft) Interface Cable	150
Y1709 1m (3.28 ft) Printer Cable	125
Y2000 Multipoint Selector, RTD	610
Y2001 Multipoint Selector, Thermocouple	610
Y2002 Alarms Output	720
Y2003 Calibrator, Thermocouple Indicator	685
Y2009 Battery Pack, Rechargeable	430
Y2010 3½" Rack Panel PTI, Single	90
Y2012 5¼" Rack Panel PTI, Single	90
Y2014 5¼" Rack Panel PTI, Single	90
Y2016 7" Rack Panel PTI, Single	90
Y2018 3.05" DIN Panel Mount PTI	90
Y2019 3.81" DIN Panel Mount PTI	90
Y2020 4.80" DIN Panel Mount PTI	90
Y2021 5.70" DIN Panel Mount PTI	90
Y2023 Accessory Case, PTI	125
Y2024 3-Module Power Cord	20
Y5020 Current Shunt 115V, 230V	670
* Y7201 Attenuator/Filter (Counters)	60
Y8021 Shielded Cable, 1m (39.4 in)	85
Y8022 Shielded Cable, 2m (78.8 in)	95
Y8023 Shielded Cable, 4m (13 ft)	105
Y8834 Single Rack Mount, 8840A	35
Y8835 Dual Rack Mount, 8840A	75
* Y9100 6 dB Attenuator	50
* Y9101 14 dB Attenuator	50
* Y9102 20 dB Attenuator	50
* Y9103 50-ohm feedthrough termination	30
* Y9106 BNC "T"	15
* Y9107 BNC "T"	10
* Y9108 BNC Jack to Double Banana Plug	10
* Y9109 BNC Plug to Binding Posts	15
* Y9110 BNC Jack for Printed Circuit Boards	15
* Y9111 Coaxial Cable 0.93m (3 ft)	15
* Y9112 Coaxial Cable 1.85m (6 ft)	15
* Y9113 BNC Plug to Double Banana Plugs	15
* Y9114 BNC Jack to Phone Plug	15
* Y9115 BNC Plug to Phone Jack	15
* Y9116 BNC Jack to Phono Plug	15
* Y9117 Phono Jack to BNC Plug	15
* M00-100-714 Dust Cover	10
* M00-200-611 3½" Rack Mount, Offset	35
* M00-200-612 3½" Rack Mount, Center	35
* M00-200-613 3½" Rack Mount, Dual	50
* 2160A-7031 3½" Rack Mount Panel, Single	90
* 2160A-7032 3½" Rack Mount Panel, Double	90
* 2160A-7033 3½" Rack Mount Panel, Triple	90

\*Available through Distributors. See page 248

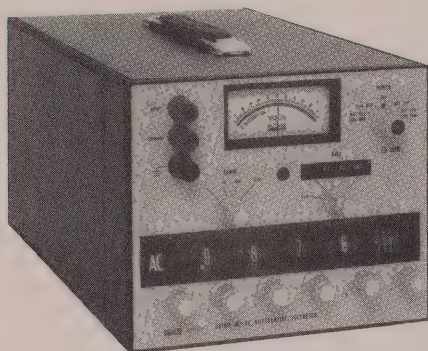


# LIMITED DEMAND PRODUCTS

## Meaning of Limited Demand

The instruments described on these pages represent a desirable choice in a few specialized cases. Recommended substitutes are usually given with the description.

## Differential Voltmeters



887AB

Fluke Differential Voltmeters, at one time, were the most accurate kind of voltmeters available. They are still exceptionally accurate but their principal remaining advantage is their extremely high input impedance for dc "at null," a setting where input voltage is most accurately measured. When measuring voltage from relatively high impedance sources, the input impedance of any voltmeter acts as a load and has a very significant effect on the accuracy of the measurement. Differential voltmeters reduce the measurement error in such cases.

Because analog meters are used on the front panel of differential voltmeters to indicate a null condition, they also provide a good visual monitor of small voltage changes and trends.

## Differential Voltmeter Selection Guide

Model	DC Resolution	AC Sensing	Infinite Impedance
893A	10 $\mu$ V	Average	To 1100V
895A	1 $\mu$ V	N/A	To 1100V
887AB	1 $\mu$ V	Average	To 11V
931B-01	No DC	True RMS	N/A

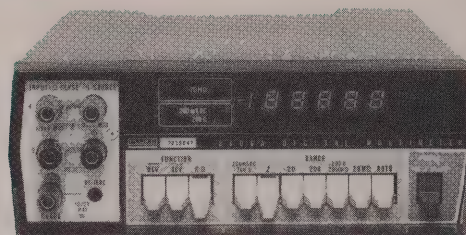
893A Differential Voltmeter	\$3365
895A Differential Voltmeter	4940
887AB Differential Voltmeter	5160
931B-01 Differential Voltmeter	4265

## 382A Voltage/Current Calibrator

The 382A combines a  $\pm 0.01\%$  voltage calibrator and a  $\pm 0.02\%$  current calibrator. Current mode offers 0 to 2A in four ranges. Voltage outputs are available in two ranges: 0 to 50V dc and 0 to 5V dc. Resolution is 10  $\mu$ V for voltage and 0.1  $\mu$ A for current with a stability of 0.005%/mo. Voltage and current limiting are adjustable. The 382A is short-circuit proof.

382A DC Voltage/Current Calibrator	\$5615
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## 8800A Digital Multimeter

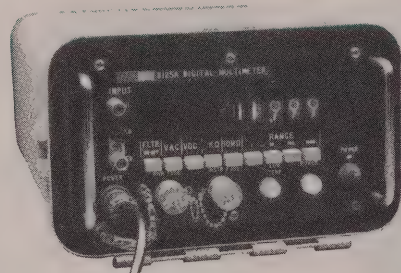


8800A

The 8810A Digital Multimeter is the recommended replacement for the 8800A. The main difference is that some functions and features which were always included with the 8800A are optional with the 8810A. Major specifications are nearly identical for the two models. In addition, the 8810A may be bought with a True RMS AC Volts Option.

8800A Digital Multimeter	\$1395
8800A-02 DMM w/Data Output	1615

## Digital Multimeter 8125A and 8425A



8125A

Model 8125A is a compact, militarized 4½-digit digital multimeter designed to meet MIL-T-28800B, Type II, Class 2, Style A requirements for rugged field applications. Prices on request.

Model 8425A is a ruggedized 5½-digit rack mounted digital multimeter, designed for system applications, that meets the requirements of MIL-T-28800B, Type II Class 4, Style B.

The functions, ranges, and performance of the 8425A are identical to those of the discontinued 8400A. Prices on request.

## 80F-15 Precision High Voltage Probe

The 80F-15 probe precisely divides inputs by 1000:1 to allow measurement of voltages to 15 kV dc. Accuracy is  $\pm 0.05\%$  of input into 10 M $\Omega$   $\pm 0.1\%$  voltmeter input, 1 year, 23°C  $\pm 1^\circ$ C.

80F-15 High Voltage Probe (10 M $\Omega$ cal)	\$695
80F-15-01 High Voltage Probe (11 M $\Omega$ cal)	695
80F-15-02 High Voltage Probe (10 <sup>10</sup> $\Omega$ cal)	695

## 8000A Digital Multimeter

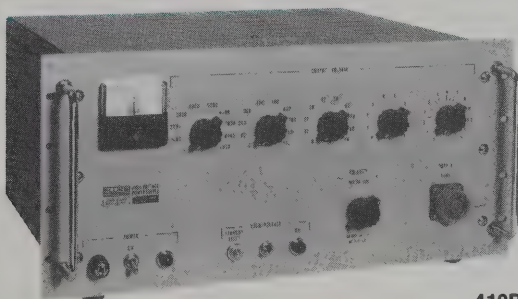


**8000A**

A classic 3½-digit DMM with LED readout. The 8010A, 8012A, or 8050A with LCD readout are recommended replacements.

8000A DMM .....	\$595
8000A-01 DMM w/Rechargeable Batteries .....	\$645
8000A/MAS for x-ray testing .....	\$795

## High Voltage Power Supplies

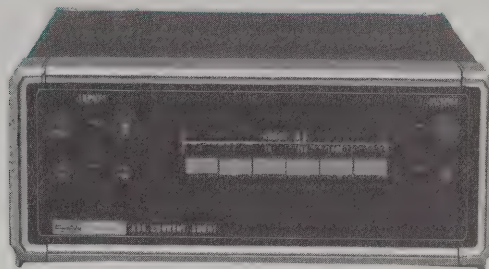


**410B**

The 410B and 415B are extremely stable dc sources that cover the range of 0 to 10,000V with 5 mV resolution and 0.25% calibration accuracy. The 410B provides 0 to  $\pm 10,000V$  at 10 mA maximum output current. The 415B covers from 0 to  $\pm 3100V$  at 30 mA maximum. Both models include adjustable over-current protection.

410B High Voltage Power Supply .....	\$4210
415B High Voltage Power Supply .....	2650

## A-90 Current Shunt



**A-90**

The model A-90 Current Shunt may be used for both ac and dc current measurements over six current ranges from 0.1 mA range to 10A range. A voltage of 100 mV, measurable with virtually any voltmeter, is developed at full scale on each range. Basic accuracy is  $\pm 0.15\%$  for dc,  $\pm 0.3\%$  for ac.

A-90 Current Shunt .....	\$535
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## 80E-10 High Voltage Divider



**80E-10**

The 80E-10 is a voltage divider designed for use with voltmeters in measuring up to 10,000V dc. Divider outputs at 10V and 1V are proportional to 10 kV dc input and are accurate to  $\pm 0.01\%$ . High measurement stability and accuracy are assured through the use of Fluke manufactured precision wire-wound resistors mounted on glass-epoxy printed circuit boards.

80E-10 High Voltage Divider .....	\$1120
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# IEEE-488 INTERFACE BUS

## System Approach to Measurement

The decision to automate a measurement process is not an easy one. Any such decision must be based on an analysis of the benefits of a system approach versus the cost of implementing it. Several of the benefits associated with a systems approach are:

- The system provides consistent, repeatable results.
- The system is not prone to operator fatigue.
- A system provides generally faster measurements, thus increasing throughput.
- An automated test system can conduct a much more thorough or complete test in the same or less time.
- A test system can be designed to vary test parameters as the test progresses (based upon data obtained in previous tests), or can branch to other points in a test program.
- Measurement accuracy can be enhanced by reducing the potential for human error. System errors can be adjusted and compensated in final test results.
- Measurement data can be recorded in computer memory and hard copy form making results easy to format and modify.
- Measurement data can be formatted directly or developed within the computer.

As a leading supplier of test instrumentation, Fluke is dedicated to simplifying the integration of the instruments and computer for test applications. Fluke uses two controllers, the 1720A and the 1722A, for IEEE-488-based systems.

Proper training and after-sale support is essential, and Fluke supplies both. Technical assistance is available through our sales offices and representatives worldwide.

## How the IEEE-488 Bus Operates

All the active IEEE-488 interface circuitry is designed into the various compatible test instruments and controllers. The connecting cable is passive. The cable contains 16 lines and connects all devices in parallel. This allows for passage of data, commands, and other information between the devices.

The instruments within an IEEE-488 system must perform at least one of the following roles: Listener, Talker or Controller. A Listener receives data from other devices on the bus. A Talker is responsible for transmitting data to other devices on the bus. There are several instruments available today that can perform both Talker and Listener roles. An IEEE-488 programmable instrument can "Listen" to receive instructions or "Talk" to transmit data back, or both. A Controller manages the operation of the IEEE-488 bus system. It designates when and which instruments are to Talk (send data) or Listen (receive instructions). It must also be able to talk and listen as well as control.

The simplest IEEE-488 system consists of a Talker and a Listener. Data transfer is limited to direct communication between an instrument designed or set to "talk only" and an other set or designed to "listen only."

The full capability of an IEEE-488 system can only be realized when a controlling instrument, such as the 1722A is added to the system. In addition to handling data, the controller becomes the system manager by commanding all devices on the bus to Talk or Listen. Only one instrument on the bus may talk at one time.

## IEEE-488 Bus Structure

The IEEE-488 interface is a "party-line" in which all devices are connected in parallel. Of the 16 signal lines in the interface, 8 of these are for data transfer, three are handshake lines, and the remaining five lines are for control of bus activity.

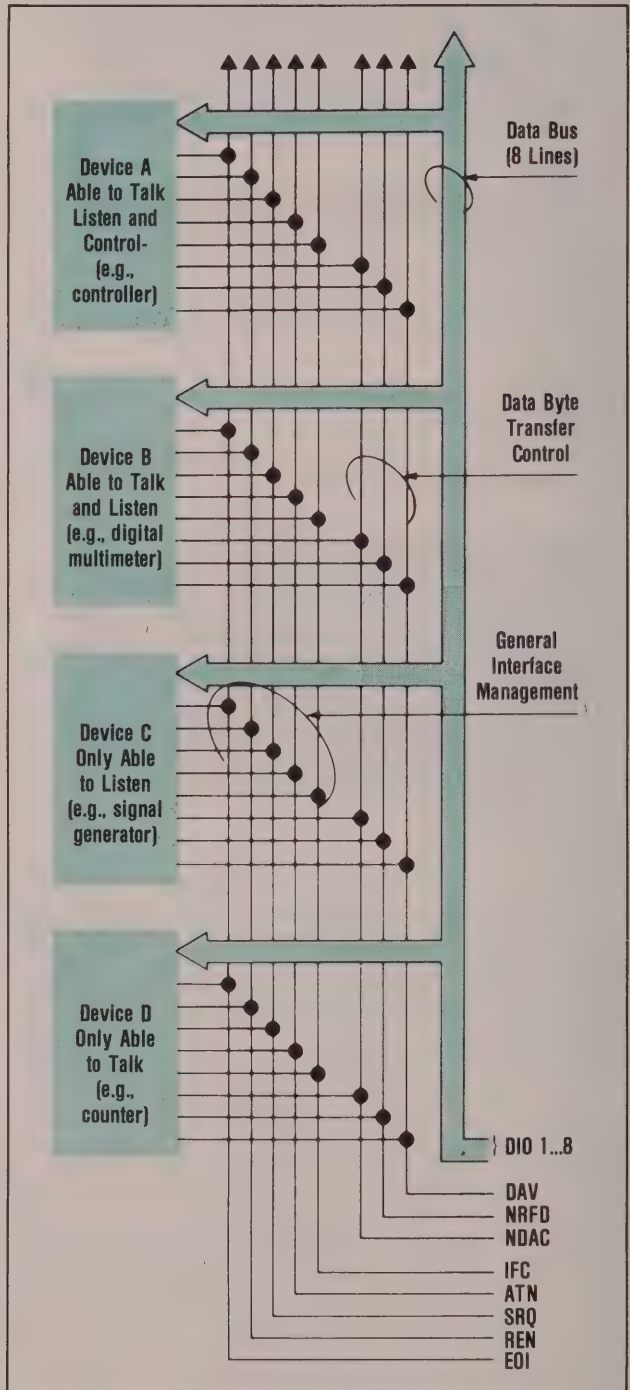


Figure 1. IEEE-488 Bus Structure

The controller dictates the role of each device connected to the bus by setting the ATN (attention) line true and sending talk or listen addresses on the data lines (DI01 through DI08). The address of each device is set: 1) at the time of manufacture, 2) by switches on the rear panel, 3) keyed in from the front panel, or 4) by jumpers on a PC board. While the ATN line is true, all devices must "listen" to the data lines. Then, when the ATN line is false, only the devices which have been addressed will send or receive data.

Several listeners can be active simultaneously but *only one* talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is True), all other talkers will be automatically unaddressed.

Information is transmitted on the data lines under sequential control of the three Handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as the devices can respond, but no faster than allowed by the slowest device presently addressed as active.

The ATN line is one of the five Control lines. When True, addresses and universal commands are transmitted on only seven of the data lines using ASCII code. When False, any code of 8 bits or less understood by both the talker and listener(s) may be used.

The other Control lines are IFC, REN, SRQ, and EOI. The IFC (interface clear) line places the interface system in a known, quiescent state. REN (remote enable) is used with other coded messages to select either local or remote control of a device. Any active device on the bus can set the SRQ (service request) line True. This indicates to the controller in the system that some device on the bus wants attention (for example a counter has just completed a measurement and wants to transmit the reading). EOI (end or identify) is used by a device to indicate the end of a multi-byte transfer. When a controller sets both the ATN and EOI lines True, each device capable of a parallel poll indicates its current instrument status on the DOI (data) line assigned to it. (A parallel poll enables the transfer of instrument status from multiple devices concurrently, while a serial poll will sequentially collect status data from each device).

It is not necessary for every device to be capable of responding to all the control lines. Each instrument can be designed to respond to only those control lines that are relevant to its function on the bus.

## IEEE-488 Specifications Summary

In general the interface system can be broken down into three categories: Mechanical, Electrical and Functional.

### Mechanical Specifications

The individual cable assembly defined in the standard can be no more than 4 meters in length, and must have a plug and receptacle connector at each end.

The connector is a 24-pin, D-type, with provisions for locking screws.

### Electrical Specifications

Up to 15 devices (1 controller and 14 instruments) can be connected on one contiguous bus. Star or linear networks are possible, however, the total transmission length cannot exceed 2 meters times the number of devices or 20 meters total (whichever is less).

Messages are transmitted over the data lines in a byte-serial, bit-parallel manner using a 3-wire handshake.

The maximum data rate for the bus is 1 megabyte per second.

Driver and receive circuits are TTL-compatible.

### Functional Specifications

The functional aspects of the interface are concerned with the content of the messages sent over the interface. Each function performed by the interface does so within a precisely defined protocol. The possible interface functions that can be implemented are in the table below.

Interface Function Table

Function	Symbol	Subsets
Source Handshake	SH	0-1
Acceptor Handshake	AH	0-1
Talker or Extended Talker	T, TE	0-8
Listener or Extender Talker	L, LE	0-4
Service Request	SR	0-1
Remote Local	RL	0-2
Parallel Poll	PP	0-2
Device Clear	DC	0-2
Device Trigger	DT	0-1
Controller	C	0-28

The designer of a bus-compatible instrument is not required to implement all the possible interface functions. However, a device must have the capability to assume the role of at least a Talker, Listener, or a Controller.



# LEASING, ORDERING INFORMATION

## Quality at Fluke

- Design reviews, computerized circuit and stress analyses, reliability calculations
- Small team-build groups on the production line
- Automated manufacturing and assembly for higher reliability
- In-house component manufacture
- Increasing vendor qualification programs
- Extensive product testing
- Training, performance standards and measures

At Fluke, Quality is not only a collection of policies and procedures, but a way of life that underlies the company's day-to-day activities and decisions and shows up as customer satisfaction with Fluke's products and services.

## Leasing

- Improves your cash flow
- Conserves your capital
- Keeps your credit lines intact
- Can cover a "market basket" of equipment
- Can be made to fit your budget
- Protects your equipment investment
- Lets you choose your next step

## Ordering Information

### Special Instruments & Systems

Many Fluke instruments can be supplied with non-standard paint, altered specification ranges, special connectors, or other special features. Some automated systems may be assembled and customized to your requirements, also. Contact the Fluke Representative or Sales Office in your area.

### Prices & Terms

Prices are F.O.B. origin unless otherwise specified, apply only when the final destination is within the U.S.A., are in U.S. funds, and are subject to change without notice.

Upon request, quotations, or pro forma invoices will be furnished to you by your Fluke Sales Representative or by John Fluke Mfg. Co., Inc.

U.S. terms are 30 days net. Unless credit has already been established, shipments will be made C.O.D. or on receipt of cash in advance. Terms for orders from other countries are either an irrevocable letter of credit or cash in advance, unless other terms have been previously arranged.

### Specifications & Calibration

Specifications quoted in this catalog are those which apply at the time of printing. The Company reserves the right to change specifications without notice.

Special calibration reports are available for a modest fee that include numerical values pertaining to the calibration, the uncertainties associated with the calibration, and statements explaining the calibration. Your local Fluke Sales Office or Representative can advise you of the fee for any special calibration report you may require. They must be thoroughly defined when an order is placed.

## Now You Can Lease Your Fluke Equipment (in the U.S.)

There's a new way to get still more value from us — through Fluke's new Leasing Program. Here are some of the reasons why. . .

**Leasing improves your cash flow.** Lease payments are made from revenue, not capital — a "pay as you earn" opportunity.

**Leasing conserves your capital.** You can acquire the equipment you need while staying within company or departmental budgets. Cash out of pocket is nominal because your lease deposit is limited to an amount equal to a single monthly lease payment.

**Leasing keeps your credit lines intact** for when they're really needed.

**Leasing** can be arranged for any single Fluke item or combined "market basket" of equipment (in the U.S.) when total equipment value is \$2,500 or more.

**Leasing fits your budget.** 12-month to 60-month payment terms are typical.

**Leasing protects your equipment investment.** Fluke warranties, maintenance agreements and other support systems are the same as for purchased equipment.

**Leasing lets you choose your next step.** At the end of your lease term you may renew your lease (for a yearly payment of 4 percent of the original equipment value), or purchase the equipment (for the lessor's "salvage value" — typically 10 percent of original equipment value), or simply return the equipment to the lessor.

**Leasing is easy.** Modest credit information on a simple application form is usually all that is needed. Only if equipment cost exceeds \$10,000 will you need to attach a current financial statement.

Fluke's authorized lessor in the U.S. is Industrial Leasing Corporation (ILC). For more than 25 years, ILC has pioneered diversified equipment leasing programs for a broad range of industries throughout the nation.

For more information on our leasing program, or for a lease-application form, contact your Fluke Sales Office (see page 243) or call Industrial Leasing Corporation direct at their national toll-free numbers anytime after 9 a.m. in your U.S. time zone:

Industrial Leasing Corporation  
Outside Oregon (800) 547-4905  
Inside Oregon (800) 452-1079

## Warranty

Fluke warrants each Product it manufactures to be free from defects in material and workmanship under normal use and service. Software is warranted to operate in accordance with its programmed instructions on appropriate Fluke Products; it is not warranted to be error free. This warranty extends only to the original Buyer and shall not apply to fuses, computer media, batteries or any Product which, in Fluke's sole opinion, has been subject to misuse, alteration or abnormal conditions of operation or handling. The warranty period shall be controlled by the warranty document furnished with each Product and shall begin on the date of shipment.

Fluke's obligation under this warranty is limited to repairing or replacing, at Fluke's option a Product which is returned to an authorized service center within the warranty period and is determined to be defective by Fluke. If Fluke determines that the defect or malfunction has been caused by misuse, alteration or abnormal conditions of operation or handling, Fluke will repair the Product and bill Buyer for the reasonable cost of repair. If the warranty period has expired, Fluke will submit an estimate of the repair costs before work is started if requested by Buyer.

To obtain repair service under this warranty, Buyer must forward the Product, transportation prepaid, and a description of the malfunction to the nearest Fluke Service Center. The Product shall be repaired at the Service Center or at the factory and returned to Buyer, transportation prepaid. The Product should be shipped in the original packing carton or a rigid container padded with at least four inches of shock absorbing material. FLUKE ASSUMES NO RISK FOR IN-TRANSIT DAMAGE.

THE FOREGOING WARRANTY IS BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSS WHETHER IN CONTRACT, TORT, OR OTHERWISE.

# U.S. GOVERNMENT SALES & SUPPORT

## U.S. General Services Administration

Most of the equipment and accessories in this catalog are available on the following General Services Administration Contracts in FSC Group 66, Part II, Sections "H" and "J", Class 6625:

Contract	Period	Category
GS00S57260 (Section H)	July 27, 1984 to May 31, 1985	Instruments and Laboratory Equipment
GS00F70562 (Section J)	August 3, 1984 to May 31, 1987	Instruments: Measuring and Testing

## Special Products, Systems, and Services

Listed below are examples of products, systems, and services that specifically support Government applications.

### Products

**Model 1720A/TT System Controller.** Presently the only system controller which has been accredited by the SCOCE to meet United States requirements for information protection. (See page 152.)

**Model 8520A/AS System Multimeter.** Certified by the Air Force as the first module to complete all requirements imposed by the Modular Automated Test Equipment (MATE) Program. (See page 15.)

**Model 8025A Multimeter (NSN 6625-01-147-6182).** A handheld instrument designed to the ruggedized requirements of MIL-T-28800 Type II, Class 2, Style A. (See page 42.)

**Model 8050A-01 Multimeter (AN/USM-486/U NSN 6625-01-145-2430).** A 4½-digit multimeter with 85 RF Probe selected by the Army as the preferred benchtop multimeter for multi-service maintenance and repair testing. (See page 29.)

**Model 8840A Digital Multimeter.** A low-cost, high-accuracy 5½-digit multimeter for bench and system applications. (See page 3.)

### Systems

**MECCA (Modularly Equipped and Configured Calibrators and Analyzers).** Provides the Navy with automatic calibration capability on-site under rigorous conditions by integrating the Fluke 1720A/AP Instrument Controller, 5102B Meter Calibrator and 8502A/AT Digital Multimeter.

**Model A123 Automated Calibration System.** A high accuracy mobile calibration system, configured to calibrate 5- and 6-digit DMMs automatically.

### Services

**Direct Voltage Maintenance Program.** (See page 121.)

**Leasing.** (See page 238.)

**Application Training.** Some of the courses presently available, including several which are complimentary with a system purchase, are identified below. Contact your local Fluke sales office or Government Operations field office for the most current information on course/seminar content and attendance considerations.

2450MCS Measurement and Control System Training Course  
3040A-1 Digital/Analog Board Test System Training Course  
3050B Digital/Analog Board Test System Training Course  
3200A Manufacturing Defect Analyzer Training Course  
6070A/6071A Signal Generator RF Seminar  
7405A/7410A-100 Automated Calibration System Intermediate Training  
9000A Micro-System Troubleshooter Introductory Training  
(Basic and Advanced courses)

**Maintenance Training.** Fluke understands the needs of certain customers to possess their own maintenance capability. Maintenance training courses currently scheduled for presentation in 1984 at various Technical Service Centers include:

2280 Data Logger  
2400 Intelligent Computer Front End  
3040/3050 Functional PCB Tester  
3200 Manufacturing Defects Tester  
3330 Calibrator  
5100/5101/5102 Calibrator  
5200 Programmable AC Calibrator  
5215 Calibrator Power Amplifier  
5440 Direct Voltage Calibrator  
8500/8502/8505/8506 DMM Portable Digital Multimeters  
4200 Series DACs

Fluke sales offices (see page 243) and the Government Operations field offices listed here have the latest information on provisioning, nomenclature, and National Stock Number information.

#### National Program and Accounts Manager

5640 Fishers Lane  
Rockville, MD 20852  
(301) 770-1570

#### Air Force Program and Accounts Manager

10417 Gulfdale  
San Antonio, TX 78216  
(512) 340-2621

4756 Fishburg Rd.  
Dayton, OH 45424  
(513) 233-2238 (Dayton)  
(614) 224-1150 (Columbus)

#### Army Program and Accounts Manager

3322 S. Memorial Pkwy.  
Suite 96  
Huntsville, AL 35801  
(205) 881-6220

1010 West 8th Ave.  
Suite H  
King of Prussia, PA 19406  
(215) 265-4040

#### Navy Program and Accounts Manager

5640 Fishers Lane  
Rockville, MD 20852  
(301) 770-1570

16969 Von Karman  
Suite 100  
Irvine, CA 92714  
(714) 863-9031

#### Security Program and Accounts Manager

5640 Fishers Lane  
Rockville, MD 20852  
(301) 770-1570

## Logistics Data Book

The Fluke Logistics Data Book is available from your local sales office. This document provides comprehensive information regarding National Stock Number, military nomenclature and replacement model numbers as well as products, systems, and services which offer benefits tailored to special government/military requirements. Detailed listings of available application and maintenance training plus technical literature are also included.



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A22-301	Tape Reader .....	196	on req.
A40 (any)	Current Shunt .....	127	430.00
	Series for 540B		
A45-4003	Input Cable .....	128	60.00
A45-4004	Input Cable .....	128	90.00
A53*	Whip Antenna .....	231	25.00
A55 (any)	Thermal Converter ...	128	535.00
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A81*	Battery Eliminator ...	233	20.00
A90	Current Shunt .....	235	535.00
A4200	Manual Control Unit ..	150	595.00
C20	Hard Carrying Case ..	57	20.00
C25	Soft Carrying Case ..	57	15.00
C41	Carrying Case .....	128	535.00
C55	Carrying Case .....	128	535.00
C70*	Multipurpose Holster ..	57	9.00
C71*	Carrying Case .....	57	9.00
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C89	Carrying Case .....	23	20.00
C90*	Carrying Case .....	57	10.00
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MEE-7003	7" Rack Adapter .....	108	160.00
MEE-8078	18" Rack Slides .....	107	125.00
MEE-8079	24" Rack Slides .....	107	135.00
MIS-7011K	Extender Card .....	11	135.00
MIS-7031K	Bus Interconnect ....	11	45.00
MIS-7190K	Static Controller .....	11	285.00
MIS-7191K	Test Module .....	11	475.00
M00-100-714*	Panel Protector .....	60	10.00
M00-200-611*	3½" Rack Adapter, ...	232	35.00
	Offset		
M00-200-612*	3½" Rack Adapter, ...	232	35.00
	Center		
M00-200-613*	3½" Rack Adapter, ...	232	50.00
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M00-200-622	3½" Rack Adapter ...	72	60.00
M00-200-625	3½" Rack Adapter ...	23	60.00
M00-200-626	3½" Rack Adapter, ...	72	130.00
	w/slides		
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	w/slides		
M00-260-610	18" Rack Slides .....	**	105.00
M00-280-610	24" Rack Slides .....	**	110.00
M03-200-618	3½" Rack Adapter, ...	105	50.00
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M03-200-619	3½" Rack Adapter, ...	105	50.00
	Offset		
M03-200-620	Panel Mounting Kit ..	105	50.00
M03-201-601	3½" Rack Adapter, ...	**	105.00
	1 Quarter		
M03-202-603	3½" Rack Adapter, ...	**	105.00
	2 Quarters		
M03-203-700	Panel Protector .....	105	25.00
M03-205-605	3½" Rack Adapter, ...	**	85.00
	Quad		
M03-206-604	3½" Rack Adapter, ...	**	105.00
	Triple		
M04-205-600	5¼" Rack Adapter ...	11	95.00
M05-200-603	5¼" Rack Adapter, ...	**	110.00
	Half		
M05-203-601	5¼" Rack Adapter, ...	**	110.00
	Half		

Model	Description	Page	Price
M05-203-602	5¼" Rack Adapter, ...	**	110.00
	Half		
M05-205-600	5¼" Rack Adapter ...	150	85.00
M07-205-600	7" Rack Adapter .....	**	100.00
M08-205-600	8¾" Rack Adapter ...	**	105.00
M10-205-600	10½" Rack Adapter ..	**	105.00
P20E*	Thermocouple Probe ..	166	60.00
P20J*	Thermocouple Probe ..	166	60.00
P20K*	Thermocouple Probe ..	166	60.00
P20T*	Thermocouple Probe ..	166	60.00
TL70*	Replacement Test ....	56	5.00
	Leads		
Y1700	Programming .....	157	395.00
Y1703	RS-232-C Null Modem	231	150.00
	4m		
Y1704	Board Extender .....	157	200.00
Y1705	RS-232-C Null Modem	231	75.00
	1 ft.		
Y1706	Blank Disks, Pkg. of 10	137	100.00
Y1707	RS-232-C 2m Cable ...	231	125.00
Y1708	RS-232-C 10m Cable ..	231	150.00
Y1709	RS-232-C 2m Printer ..	231	125.00
	Cable		
Y1711	Shipping Case for ...	157	300.00
	1720A & 1722A		
Y1720	Programming .....	159	350.00
	Keyboard		
Y1790	5¼" Rack Adapter ...	157	175.00
	w/Slides		
Y1791	Rack Adapter .....	159	95.00
Y1792	Rack Adapter w/Cable	159	195.00
Y1793	Carrying Handle .....	159	40.00
Y1794	Rack Adapter .....	**	175.00
	w/Slides		
Y1795	Carrying Handle .....	15	48.00
Y2000	RTD Multipoint Selector	169	610.00
Y2001	Thermocouple .....	169	610.00
	Multipoint		
Y2002	Alarms Output .....	169	720.00
Y2003	Thermocouple .....	169	685.00
	Calibrator		
Y2004	Carrying Case & .....	166	195.00
	Battery Pack		
Y2005	Carrying Case .....	166	45.00
Y2009	12V Battery Pack ....	170	430.00
Y2010	3½" Rack Adapter ...	232	90.00
	Style A		
Y2012	5¼" Rack Adapter, ...	232	90.00
	Style B		
Y2014	5¼" Rack Adapter, ...	232	90.00
	Style C		
Y2016	7" Rack Adapter, ....	232	90.00
	Style D		
Y2018	97mm Panel Mount, ..	233	90.00
	Style A		
Y2019	97mm Panel Mount, ..	233	90.00
	Style B		
Y2020	122mm Panel Mount, .	233	90.00
	Style C		
Y2021	145mm Panel Mount, .	233	90.00
	Style D		
Y2022	T/C Calibrator .....	172	125.00
	Divider		
Y2024	3-Way Power Cord ...	233	20.00
Y2026B	RS-232-C Cable .....	172	170.00
	Adapter		

Model	Description	Page	Price
Y2028	BCD to PTI .....	143	455.00
	Converter		
Y2030	Input Module for 2190A	172	90.00
Y2031	Input Module for 2180A	172	90.00
Y2035	Thermal Paper, .....	180	65.00
	10 rolls		
Y2036	3-Way PTI Cable .....	173	80.00
	Adapter		
Y2037	Pt 390 RTD Probe ....	173	260.00
Y2039	Pt 392 RTD Probe ....	173	700.00
Y2042	DC-100 Cartridges, ...	196	130.00
	Pkg/5		
Y2044	8¾" Rack Adapter, ...	196	195.00
	w/Slides		
Y2045	8¾" Rack Adapter, ...	196	120.00
	w/o Slides		
Y2046	Printer Paper, .....	196	50.00
	Pack of 10		
Y2047	Multi-Connector/ ....	196	75.00
	Adapter		
Y5000	Interface Buffer .....	116	535.00
Y5002	Interface Cable .....	116	215.00
Y5020	Current Shunt (Calib)	117	670.00
Y6001	5¼" Rack Adapter ...	85	260.00
	w/Slides		
Y7201*	Attenuator/Filter ....	231	60.00
Y7203	2-ft Ribbon Cable, ...	174	45.00
	PTI		
Y7204	5-ft Ribbon Cable, ...	174	60.00
	PTI		
Y7205	6-ft Ribbon Cable ....	90	70.00
Y7206	3½" Rack Adapter ...	72	110.00
	w/Slides		
Y8021	1m Cable for IEEE-488	231	85.00
	Bus		
Y8022	2m Cable for IEEE-488	231	95.00
	Bus		
Y8023	4m Cable for IEEE-488	231	105.00
	Bus		
Y8004	RS-232 1.5m Cable ...	100	105.00
Y8007	Ten Pack of Mini- ....	**	150.00
	Cassettes		
Y8013	DVM Trigger Cable ...	112	25.00
Y8076	Analog Interface Cable	210	125.00
Y8100*	DC/AC Current Probe	59	199.00
Y8101*	AC Current Probe ....	60	59.00
Y8102*	Sheathed K .....	58	60.00
	Thermocouple		
Y8103*	Bead K Thermocouple	58	25
Y8104*	Thermocouple .....	58	10.00
	Termination Kit		
Y8105*	Carrying Case .....	57	20.00
Y8110*	Thermocouple Wire, ..	166	65.00
	100 ft, J		
Y8111*	Thermocouple Wire, ..	166	110.00
	100 ft, K		
Y8112*	Thermocouple Wire, ..	166	110.00
	100 ft, T		
Y8113*	Thermocouple Wire, ..	166	110.00
	100 ft, E		
Y8114*	Thermocouple .....	166	15.00
	Extension Plug, J		
Y8115*	Thermocouple .....	166	15.00
	Extension Plug, K		
Y8116*	Thermocouple .....	166	15.00
	Extension Plug, T		
Y8117*	Thermocouple .....	166	15.00
	Extension Plug, E		



# ACCESSORIES INDEX

Model	Description	Page	Price	Model	Description	Page	Price	Model	Description	Page	Price
Y8131*	Test Leads .....	56	10.00	Y9316	BNC Capacitor .....	85	5.00	5100A-7003K	Carrying Case .....	100	590.00
Y8132*	Test Leads .....	56	10.00	Y9317	Type N 50Ω .....	85	90.00	5100A-7005K	Extender Kit .....	100	430.00
	(Shrouded)				Termination			5200A-7015K	Extender Board Kit	103	250.00
Y8133*	Test Lead Set .....	56	20.00	80E-10	High Voltage .....	235	1120.00	5440A-7001	Storage Module .....	96	210.00
Y8134*	Test Lead Set .....	56	20.00		Divider			5440A-7003	Low Thermal Cables	96	315.00
	(Shrouded)			80F-15	High Voltage Probe	234	695.00	9000A-200	Pod Adapter Pkg ....	217	195.00
Y8140*	Slim Test Leads .....	56	20.00	80I-400*	AC Current Probe	60	69.00	9000A-900	Transit Case .....	217	295.00
Y8205*	Carrying Case .....	56	35.00	80I-600*	AC Current Probe	60	99.00	9000A-910	Utility Tape .....	217	95.00
Y8597	Interface Adapter ....	18	150.00	80J-10*	AC/DC Current .....	60	30.00				
Y8598	3½" Rack Adapter ...	18	100.00		Shunt						
	w/Slides			80K-6*	High Voltage Probe	59	45.00				
Y8599	3½" Rack Adapter ...	18	65.00	80K-40*	High Voltage Probe	59	80.00				
Y8833	Memory Cartridge ...	21	75.00	80T-H*	Touch and Hold .....	57	45.00				
					Probe						
Y9100*	BNC Attenuator 2X ...	230	50.00	80T-SP*	Surface Tempera- ....	58	95.00				
	(6 dB)				ture Probe						
Y9101*	BNC Attenuator 5X ...	230	50.00	80T-150C*	Temperature Probe ...	58	120.00				
	(14 dB)				(°C)						
Y9102*	BNC Attenuator 10X ..	230	50.00	80T-150F*	Temperature Probe ...	58	120.00				
	(20 dB)				(°F)						
Y9103*	BNC Feed Thru .....	230	30.00	83RF*	RF Probe .....	58	49.00				
	Termination			85RF*	RF Probe .....	58	85.00				
Y9104*	Insulated Alligator ...	56	12.00								
	(Pin Tip) Pkg/6			540B-103	7" Rack Adapter .....	127	110.00				
Y9106*	BNC T 3 Jacks .....	230	15.00	540B-110	Rechargeable Battery	127	390.00				
Y9107*	BNC Jack, Plug, Jack	230	10.00		Pack						
Y9108*	BNC Receptacle to ...	230	10.00	881A-102	7" Rack Adapter, ....	235	145.00				
	Double Banana				Single						
Y9109*	Binding Post to BNC .	230	15.00	881A-103	7" Rack Adapter, ....	235	100.00				
	Plug				Dual						
Y9110*	BNC-to-PCB Pins .....	230	15.00	891A-7001K	Battery Kit/893A .....	235	235.00				
Y9111*	BNC Coax 50Ω, 3 ft ..	231	15.00	891A-7002K	Recorder Kit/893A ...	235	135.00				
Y9112*	BNC Coax 50Ω, 6 ft ..	231	15.00	1765A/AB	10M-Byte Winchester .	157	4250.00				
Y9113*	BNC to Banana Plug .	230	15.00		Disk						
Y9114*	BNC Recept-to-phone	230	15.00								
	Jack			2010A-7013	Printer Paper .....	196	35.00				
Y9115*	Phone Jack to BNC ..	230	15.00	2010A-7014	Printer Ribbon .....	196	35.00				
	Plug			2160A-7012*	Conversion Kit, .....	166	35.00				
Y9116*	BNC Recept-to-phone .	230	15.00	2160A-7013*	Conversion Kit, .....	166	35.00				
	Plug				S Type						
Y9117*	Phone Jack to BNC ..	230	15.00	2160A-7014*	Conversion Kit, .....	166	35.00				
	Plug				B Type						
Y9134*	Alligator Clips, .....	56	17.00	2160A-7015*	Conversion Kit, .....	166	35.00				
	5 Red, 5 Black				C Type						
Y9300	Directional Coupler ..	85	210.00	2160A-7016*	Conversion Kit, .....	166	35.00				
Y9301	50Ω to 75Ω Adapter ..	85	260.00		J Type						
Y9302	Type N 3 dB .....	85	85.00	2160A-7017*	Conversion Kit, .....	166	35.00				
	Attenuator				K Type						
Y9303	Type N 6 dB .....	85	90.00	2160A-7018*	Conversion Kit, .....	166	35.00				
	Attenuator				T Type						
Y9304	Type N 10 dB .....	85	90.00	2160A-7019*	Conversion Kit, .....	166	35.00				
	Attenuator				E Type						
Y9305	Type N 20 dB .....	85	90.00	2160A-7031*	3½" Rack Panel, ....	232	90.00				
	Attenuator				Single						
Y9306	Type N 30 dB .....	85	90.00	2160A-7032*	3½" Rack Panel, ....	232	90.00				
	Attenuator				Double						
Y9307	Type N-to-BNC 75Ω ..	85	15.00	2160A-7033*	3½" Rack Panel, ....	232	90.00				
	Adapter				Triple						
Y9308	Type N-to-BNC 50Ω ..	85	15.00								
	Adapter			2200A-7001	Cable Assembly .....	196	165.00				
Y9309	Type N (Male to N ...	85	15.00	2200A-7002	Cable (per foot) .....	196	5.00				
	(Male) Adapter			2200A-7003	Scanner Adapter ....	196	58.00				
Y9310	Type N (Male to .....	85	40.00	2200A-7005	Extender Cable Set	196	250.00				
	SMA Adapter			2200A-7006	I/O Cable .....	196	180.00				
Y9311	RF Detector .....	85	135.00	2200A-12/AG	Remote Start Card ...	196	on req.				
Y9312	Double Balanced Mixer	85	95.00	2200A-16/AA	Battery/Crystal .....	196	on req.				
	10 MHz				Clock						
Y9313	Double Balanced Mixer	85	95.00	2240A/ACK	Crystal Clock Kit ....	196	on req.				
	1 GHz			2240A-33/AL	AC Scanner .....	196	on req.				
Y9314	Power Splitter .....	85	90.00	4210A-4014	Extender Card .....	150	75.00				
Y9315	Type N Coaxial Cable	85	60.00	4270A-4303	Extender Card .....	150	75.00				

\*Distributor stock item

\*\*Not described but listed with any relevant instrument

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## G

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(805) 964-6824 RPS  
**Hayward**  
(415) 783-1911 DUN  
**Inglewood**  
(213) 678-7644 HUR  
(213) 671-7066 NEW  
**Irvine**  
(714) 556-6500 MAR  
(714) 660-1411 PRI  
(714) 751-3941 WST  
(714) 851-9953 WYL  
(714) 863-9953 WYL  
**Long Beach**  
(213) 537-5375 HUR  
**Los Angeles**  
(213) 685-7020 EIL  
(213) 724-2222 GIS  
(213) 388-0621 ITC  
(213) 776-8831 ITC  
(213) 685-4340 MET+  
**Monterey**  
(408) 375-3144 ZKT  
**North Hollywood**  
(213) 877-5518 BJW\*  
**Oakland**  
(415) 834-5888 BRI  
**Oceanside**  
(619) 722-7694 HUR  
(619) 439-7541 PEP

**Ontario**  
(714) 622-3513 HUR  
**Oxnard**  
(805) 483-0133 HUR  
**Palo Alto**  
(415) 968-0313 MET+  
(415) 326-5432 ZAC  
**Rancho Cordova**  
(916) 638-5282 WYL  
**Sacramento**  
(916) 444-8070 DUN  
**San Bernardino**  
(714) 885-0721 HUR  
**San Diego**  
(619) 235-6041 HUR  
(619) 268-8344 INE  
(619) 578-9606 MAR  
(619) 560-4841 MET+  
(619) 292-5611 RPS  
(619) 573-0983 THX\*  
(619) 578-2102 WAS  
(619) 565-9171 WYL  
**San Francisco**  
(415) 957-1282 ASC  
(415) 626-1444 ZAC  
**San Jose**  
(408) 294-8361 KBT  
(408) 998-5900 QUE  
**San Mateo**  
(415) 572-6600 USI  
(415) 579-0911 USI  
**San Ramon**  
(415) 820-5666 ELT  
**Santa Ana**  
(714) 971-2992 HUR  
**Santa Clara**  
(408) 727-0396 EIL  
(408) 980-1300 RGB  
(408) 988-4466 WAS  
(408) 727-2500 WYL  
**Santa Rosa**  
(707) 545-8702 HAL  
**Sunnyvale**  
(408) 734-9660 CMK  
(408) 739-8720 MAR  
(408) 745-6020 TKS  
**Vallejo**  
(707) 644-6676 ZKT  
**Van Nuys**  
(213) 782-7904 AVI  
(213) 781-8410 HUR

## Colorado

**Aurora**  
(303) 364-8325 RRI  
**Colorado Springs**  
(303) 636-1661 COL  
**Denver**  
(303) 534-3531 ASC  
(303) 534-4160 EIL  
(303) 427-9809 ELT  
(303) 373-2166 GIS  
(303) 427-1800 MAR  
(303) 757-3351 NEW  
(303) 744-1992 REP  
(303) 292-6900 STS  
**Englewood**  
(303) 779-4494 BET  
(303) 790-0523 USI  
**Thornton**  
(303) 457-9953 WYL

## Connecticut

**Danbury**  
(203) 792-7274 PIL  
**Greenwich**  
(203) 531-4880 WIS  
**Hartford**  
(203) 527-1881 HAT  
**Middletown**  
(203) 346-6646 EIL  
**New Haven**  
(203) 787-5921 HAT  
**Norwalk**  
(203) 853-1515 PIN

**South Windsor**  
(203) 289-6853 SCL  
**Stratford**  
(203) 375-5866 HAT  
**Wallingford**  
(203) 265-9333 CON  
(203) 265-3822 MAR  
**Waterbury**  
(203) 755-1181 HAT

## Delaware

**New Castle**  
(302) 322-2211 AVI  
**Wilmington**  
(302) 656-9988 WHO

## District of Columbia

**Washington**  
(202) 529-6020 WSJ

## Florida

**Altamonte Springs**  
(305) 834-9090 PIN  
**Bradenton**  
(813) 756-9571 LEA  
 **Ft. Lauderdale**  
(305) 928-0661 MAR  
(305) 771-7520 PIN  
(305) 563-4131 SEE  
**Jacksonville**  
(904) 356-4851 EMS  
**Lakeland**  
(813) 686-8193 LEA  
**Largo**  
(813) 541-4434 GRA  
**Melborne**  
(305) 254-5274 LEA  
**Miami**  
(305) 592-2636 BRO  
(305) 871-3500 EEC  
(305) 593-6060 ESL  
**Orlando**  
(305) 855-4920 AVI  
(305) 843-6770 BRO  
(305) 849-6060 EMS  
(305) 841-1878 MAR  
**Palm Bay**  
(305) 725-8300 EIL  
**Pembroke Park**  
(305) 961-9301 ASC  
**Pensacola**  
(904) 432-6916 ESU  
**Tampa**  
(813) 855-6002 BRO  
(813) 253-0104 EMS  
(813) 870-3315 LEA  
**West Palm Beach**  
(305) 659-7166 DOL

## Georgia

**Albany**  
(912) 435-1711 SPD  
**Athens**  
(404) 548-1334 SPD  
**Atlanta**  
(404) 762-5181 BRO  
(404) 873-2521 SPD  
(404) 458-6341 SPD  
(404) 447-8431 WIE  
**Augusta**  
(404) 722-2055 DIX  
(404) 722-1526 SPD  
**Brunswick**  
(912) 265-1927 SPD  
**Chamblee**  
(404) 458-4416 ASC  
**College Park**  
(404) 763-3828 SPD

**Columbus**  
(404) 327-7414 SPD  
**Decatur**  
(404) 325-0165 EME  
**Macon**  
(912) 743-5421 SPD  
**Marietta**  
(404) 422-4333 SPD  
**Norcross**  
(404) 925-1895 MAR  
(404) 446-0166 MET  
(404) 448-1711 PIN  
**Savannah**  
(912) 234-1684 SPD  
**Valdosta**  
(912) 242-4910 SPD

## Hawaii

**Honolulu**  
(808) 949-5564 HON  
(808) 533-6095 IND  
(808) 845-6402 KEM  
(808) 521-3350 KEM

## Idaho

**Twin Falls**  
(208) 733-5636 IDA

## Illinois

**Bensenville**  
(312) 595-6633 MAR  
**Bridgeview**  
(312) 430-2292 EIL  
**Champaign**  
(217) 356-1896 KLA  
**Chicago**  
(312) 638-4411 NEW  
**Downers Grove**  
(312) 964-2440 ASC  
**Elk Grove Village**  
(312) 593-8650 MET  
(312) 437-9680 PIN  
**Inverness**  
(312) 991-9770 USI  
**Joliet**  
(815) 729-0820 AVI  
**LaSalle**  
(217) 223-7400 KLA  
**Loves Park**  
(815) 877-0241 BCC  
**Niles**  
(312) 297-4200 JOS  
**Peoria**  
(309) 691-4840 KLA  
**Quincy**  
(217) 223-7560 KLA  
**Rockford**  
(815) 962-8036 MIA  
**Rolling Meadows**  
(312) 394-5441 COM  
**Schaumburg**  
(312) 490-0755 MAR

## Indiana

**Fort Wayne**  
(219) 423-3422 GRA  
**Indianapolis**  
(317) 545-1373 EIL  
(317) 634-8202 GRA  
(317) 547-8808 MAR  
(317) 849-7300 PIN  
**Lafayette**  
(317) 423-5564 GIS



# AUTHORIZED DISTRIBUTORS

## Iowa

Eldridge  
(319) 285-8484 KLA

## Kansas

Industrial Airport  
(913) 791-7000 NOR

## Kentucky

Calvert City  
(502) 395-7171 MCJ  
Louisville  
(502) 454-3420 EIL  
(502) 637-7674 PEE  
Pikeville  
(606) 432-2101 MCJ

## Louisiana

Alexandria  
(318) 433-4517 RAL  
Baton Rouge  
(504) 924-6826 BET  
(504) 272-4420 BRG\*  
(504) 344-8114 RAL  
Hanrahan  
(504) 733-8355 IIV  
Kenner  
(504) 466-3401 BRG\*  
(504) 467-6363 BUT  
Lafayette  
(318) 234-1405 BRG\*  
(318) 233-0105 RAL  
Lake Charles  
(318) 439-2493 RAL  
(318) 439-1370 RAW  
Morgan City  
(504) 383-9831 RAL  
New Iberia  
(318) 369-9816 RAL  
New Orleans  
(504) 733-3466 BRW  
(504) 525-8222 WBA  
Shreveport  
(318) 636-0310 BRW  
(318) 222-2063 WES

## Maine

See Massachusetts

## Maryland

Baltimore  
(301) 661-5900 SUN\*  
Gaithersburg  
(301) 840-0228 MAR  
(301) 921-0660 PIN†  
(301) 258-9888 USI  
Sparks  
(301) 771-4800 EIL

## Massachusetts

Burlington  
(617) 272-5051 CON  
(617) 272-9450 EIL  
(617) 272-8200 MAR  
Cambridge  
(617) 491-5500 KAU  
Lexington  
(617) 861-9200 PIN

N. Billerica  
(617) 667-8541 AST\*  
Natick  
(617) 237-1134 CAL  
Needham  
(617) 449-1005 YDI  
Woburn  
(617) 935-7820 BRO

## Michigan

Flint  
(313) 762-5800 RSE  
Grand Rapids  
(616) 241-3483 RSE  
Kalamazoo  
(616) 381-5470 RSE  
Livonia  
(313) 525-1090 ASC  
(313) 525-5850 MAR  
(313) 525-1800 PIN  
(313) 525-1155 RSE  
Madison Heights  
(313) 588-2300 NID\*  
Oak Park  
(313) 967-0600 NEW  
Roseville  
(313) 779-2450 RSE  
Wyandotte  
(313) 282-5880 RSE

## Minnesota

Bloomington  
(612) 854-1400 DIG  
Burnsville  
(612) 894-6154 ATR  
Minneapolis  
(612) 544-8916 INS  
(612) 231-6350 NEW  
(612) 888-4444 OLS  
(612) 544-4035 PMC  
(612) 332-1325 STA  
Minnetonka  
(612) 935-5444 PIN  
Plymouth  
(612) 559-2255 MAR  
St. Paul  
(612) 483-3322 GOE

## Mississippi

Columbus  
(601) 328-6212 BLU  
Tupelo  
(601) 842-6832 BLU

## Missouri

Kansas City  
(816) 421-8250 ASC  
(816) 931-0250 ESU  
(816) 333-6569 ISL  
(816) 358-7272 PAL  
St. Louis  
(314) 535-5760 ISL\*  
(314) 426-4500 OLI

## Montana

See Colorado, Oregon  
or Washington

## Nebraska

Lincoln  
(402) 466-8221 SCO

North Platte  
(308) 532-9260 SCO  
Omaha  
(402) 734-6750 SCO

## Nevada

Las Vegas  
(702) 384-5666 HUR  
(702) 733-3888 KIE  
Reno  
(702) 329-1308 NEV

## New Hampshire

Manchester  
(603) 627-9191 CON

## New Jersey

Edison  
(201) 287-2030 BRO  
(201) 494-1500 USI  
Fairfield  
(201) 227-7720 AMP  
(201) 882-0169 MAR  
Mt. Laurel  
(609) 778-8720 MAR  
Ocean  
(201) 544-0666 RAG\*  
Paramus  
(201) 444-8717 ROU  
Pennsauken  
(609) 488-0474 EIL  
Pinebrook  
(201) 227-1262 PIN  
Saddle Brook  
(201) 478-2203 TOO  
Springfield  
(201) 379-7710 ROU  
Totowa  
(201) 256-8555 ROU  
Wyckoff  
(201) 891-9560 ASC

## New Mexico

Albuquerque  
(505) 292-3360 ALI  
(505) 299-7658 BET  
(505) 293-6161 EPC  
(505) 345-5311 GIS  
Las Cruces  
(505) 523-4578 EPC

## New York

Albany  
(518) 438-7811 EET  
Buffalo  
(716) 884-3450 SUM  
Clarence  
(716) 634-8500 TRO  
Corning  
(607) 962-0555 COR  
East Syracuse  
(315) 437-3090 CON  
Elmford  
(914) 592-7100 ACR  
Endwell  
(607) 754-1570 MAR  
Fairport  
(716) 381-7070 PIN  
Great Neck  
(516) 487-7430 INM  
Hauppauge  
(516) 231-6333 EIL  
(516) 273-1515 MAR  
(516) 231-9200 PIN

Long Island City  
(212) 361-1100 DAL  
New Hyde Park  
(212) 347-2222 BRU  
New York  
(212) 730-7030 ADV  
(212) 691-1171 BRO  
(212) 732-8163 HHS  
(212) 575-5194 TAF  
Pittsford  
(716) 586-8251 TRO  
Pleasantville  
(914) 769-8070 ETC  
Port Chester  
(914) 939-3940 WIS  
Rochester  
(716) 442-2430 EIL  
(716) 235-7820 MAR  
(716) 454-7800 ROC  
(716) 334-8110 SUM  
(716) 458-4801 TRA  
Rome  
(315) 337-5400 ROM  
Syracuse  
(315) 422-2336 ROM  
Vestal  
(607) 748-8211 PIN  
Woodbury, Long Island  
(516) 921-8700 PIN

## North Carolina

Charlotte  
(704) 597-1270 BRO  
(704) 377-5413 DIX  
(704) 527-8188 PIN  
(704) 376-2237 TRO  
Greensboro  
(919) 273-4441 PIN  
Raleigh  
(919) 876-6524 BRO  
(919) 872-5456 MEM\*  
Winston-Salem  
(919) 724-5961 DIX

## North Dakota

Fargo  
(701) 237-5003 SAS

## Ohio

Cincinnati  
(513) 772-1661 GRA  
(513) 351-2000 HUG  
Cleveland  
(216) 651-4100 MET  
(216) 587-3600 PIN  
Columbus  
(614) 895-1590 GRA  
(614) 294-5351 HUG  
Dayton  
(513) 435-2134 EIL  
(513) 236-8112 MAR  
(513) 435-4503 NID\*  
(513) 236-9900 PIN†  
Independence  
(216) 524-7356 NID\*  
Maumee  
(419) 893-0721 RSE  
Solon  
(216) 248-1788 MAR  
Valley View  
(216) 447-8860 NEW  
Warren  
(216) 373-1300 REM

## Oklahoma

Ada  
(405) 332-3022 TWE

Ardmore  
(405) 223-8540 TWE  
Enid  
(405) 234-6078 TWE  
Lawton  
(405) 355-3956 TWE  
McAlester  
(918) 423-6716 TWE  
Muskogee  
(918) 682-2457 TWE  
Oklahoma City  
(405) 943-9811 BRW  
(405) 524-4411 TWE  
(405) 528-2391 WES  
Oklmulgee  
(918) 756-2060 TWE  
Ponca City  
(405) 762-5621 TWE  
Tulsa  
(918) 663-1040 BRW  
(918) 627-1500 INO\*  
(918) 663-1247 NEI\*†  
(918) 836-0286 TRI  
(918) 585-5718 TWE

## Oregon

Beaverton  
(503) 626-6633 CMK  
Hillsboro  
(503) 640-6000 WYL  
Milwaukie  
(503) 653-6781 ELT  
Portland  
(503) 232-3404 RAD  
(503) 233-5341 UNI

## Pennsylvania

Braddock  
(412) 351-5000 LEF  
Drexel Hill  
(215) 449-2300 KAS  
Erie  
(814) 453-5626 REM  
Fort Washington  
(215) 643-4050 GIS  
Philadelphia  
(215) 748-3010 SEL  
(215) 673-5600 SUN\*  
Pittsburgh  
(412) 963-1885 CAM  
(412) 731-5230 EIL  
(412) 892-2953 NID\*  
(412) 782-2300 PIN  
Plymouth Meeting  
(215) 825-4990 TEC  
Treves  
(215) 364-2830 BRO  
York  
(717) 854-7804 YIS

## Puerto Rico

Ponce  
(809) 843-2260 TRE  
San Juan  
(809) 751-8375 BAC

## Rhode Island

Cranston  
(401) 944-2570 JAB  
Pawtucket  
(401) 728-4600 JAB

## South Carolina

Charleston  
(803) 722-2634 WIE



# AUTHORIZED DISTRIBUTORS

**Columbia**  
(803) 772-6111 BRO  
(803) 779-5332 DIX  
(803) 256-0746 WIE  
**Florence**  
(803) 669-8201 DIX  
**Greenville**  
(803) 292-1430 DIX  
(803) 235-8334 WIE

## South Dakota

See Minnesota or Kansas

## Tennessee

**Chattanooga**  
(615) 267-9531 SPD  
**Gray**  
(615) 247-7125 DIX  
**Jackson**  
(901) 424-0236 BLU  
(901) 422-6585 LAV  
**Knoxville**  
(615) 966-3441 BRO  
(615) 938-4131 DIX  
**Memphis**  
(901) 345-9500 BLU  
(901) 795-8487 BRO  
**Nashville**  
(615) 242-8000 BLU  
(615) 889-8230 BRO  
(615) 242-2682 GRA  
**Paris**  
(901) 642-7354 LAV

## Texas

**Amarillo**  
(806) 372-5668 TWE  
**Austin**  
(512) 452-0199 BET  
(512) 926-9220 BRW  
(512) 458-5654 MAR  
(512) 432-6222 NEI\*  
(512) 835-4000 PIN  
(512) 835-1052 RED  
**Beaumont**  
(713) 833-9443 RAL  
(713) 838-0393 RAW  
**Borger**  
(806) 274-5281 TWE  
**Corpus Christi**  
(512) 883-3538 BRW  
(512) 887-0001 RAW  
**Dallas**  
(214) 631-3380 ASC  
(214) 631-3600 BRW  
(214) 363-8900 BUT  
(214) 243-6391 DAA  
(214) 931-1236 EIL  
(214) 243-7000 INO\*  
(214) 233-7650 MAR  
(214) 233-0020 NEI\*  
(214) 386-7300 PIN  
(214) 653-1041 RED  
(214) 358-4663 SPE  
(214) 824-3001 WES  
**Deer Park**  
(713) 479-9705 RAW  
**El Paso**  
(915) 779-5697 RED  
**Fort Worth**  
(817) 336-5621 BRW  
(817) 877-5100 INO\*  
(817) 534-2752 TWE  
(817) 336-0461 WES  
**Freeport**  
(409) 233-5451 BRW  
(409) 233-6381 RAW  
**Garland**  
(214) 271-5671 MET  
(214) 494-5911 NEW

**Greenville**  
(214) 455-4360 LAV  
**Houston**  
(713) 688-9971 BET  
(713) 694-2771 BRO  
(713) 672-1100 BRW  
(713) 464-4662 BUT  
(713) 271-3100 EIL  
(713) 688-7000 INO\*  
(713) 789-9300 MAR  
(713) 777-1666 NEI\*  
(713) 783-1629 NEW  
(713) 988-5555 PIN  
(713) 748-4902 RAL  
(713) 641-0267 RAL  
(713) 688-8126 RAW  
(713) 789-6610 SPE  
(713) 223-4811 WAY

**Hurst**  
(817) 589-1355 NEW  
**La Porte**  
(409) 471-1900 BRW  
**Lone Star**  
(214) 656-2584 BRW  
**Longview**  
(214) 757-3961 WES  
**Lubbock**  
(806) 747-2888 TWE  
**Lufkin**  
(409) 632-9900 BRW  
**McAllen**  
(512) 631-1168 RED  
**Midland**  
(915) 694-9657 ESI  
(915) 684-4469 TWE  
**Nederland**  
(409) 722-8044 BRW  
**Odessa**  
(915) 333-3636 BRW  
**Paris**  
(214) 785-1711 LAV  
**Port Lavaca**  
(512) 552-7525 RAW  
**Richardson**  
(214) 783-1065 BET  
(214) 690-4646 TWE  
(214) 234-3392 USI  
(214) 235-9953 WYL  
**San Antonio**  
(512) 333-7710 BRW  
(512) 349-2967 RAW  
(512) 340-2306 RED  
**Sherman**  
(214) 893-9585 BRW  
(214) 892-9155 LAV  
(214) 893-7421 TWE  
**Texas City**  
(713) 948-3446 RAW  
**Tyler**  
(214) 593-8421 BRW  
(214) 597-6315 LAV  
**Victoria**  
(512) 575-4738 LAV  
**Wichita Falls**  
(817) 322-5509 BRW  
(817) 322-2151 TWE  
(817) 723-8106 WES

## Utah

**Salt Lake City**  
(801) 973-4455 BET  
(801) 487-3151 INI  
(801) 486-3371 SSC  
(801) 974-9953 WYL

## Vermont

See Massachusetts or New York

## Virginia

**Alexandria**  
(703) 354-4330 EIL  
**Arlington**  
(703) 524-6256 ARL  
**Fairfax**  
(703) 591-7410 ASC  
**Norfolk**  
(804) 855-0105 PEL  
**Richmond**  
(804) 275-1431 MEM\*  
**Vienna**  
(703) 938-3350 EEB

## Washington

**Bellevue**  
(206) 455-5367 ELT  
(206) 641-6800 MAR  
(206) 451-9393 UNI  
(206) 453-8300 WYL  
**Seattle**  
(206) 762-0880 EIL  
(206) 682-4444 NCE  
(206) 282-2511 RAD  
(206) 284-6186 VAN  
**Spokane**  
(509) 747-3053 RAD

## West Virginia

**Charleston**  
(304) 348-5211 MCJ  
**Princeton**  
(304) 425-7594 MCJ

## Wisconsin

**Green Bay**  
(414) 435-8331 NRT  
**Mequon**  
(414) 241-4321 TAY  
**Milwaukee**  
(414) 475-6000 MES

## Wyoming

See Colorado, Nebraska, or Utah

\*2160/2170 Series Digital Thermometers also available through this distributor.  
†9000 Series Micro-System Troubleshooters also available through this distributor.

## Distributors

**ACR** Ancar Electronics Supply  
**ADV** Advance Electronics  
**ALA** Alaska Electronics Supply  
**ALI** Alliance Electronics  
**AMP** Ampower  
**ARL** Arlington Electronic  
**ASC** Ames Supply Co  
**AST** AST/Servo Systems  
**ATR** Atrix Tool  
**AVI** Avionics Associates  
**BAC** B & C Calibration Center  
**BCC** Barber-Colman Co.  
**BET** Beta Distributors  
**BJW** B.J. Wolfe  
**BLU** Bluff City Electronics  
**BNC** B & C Instruments  
**BRG** Breard-Gardner  
**BRI** Brill Electronics Products  
**BRO** Brownell Electro  
**BRU** Bruckner Machine & Tool  
**BRW** Briggs-Weaver  
**BUT** Butler & Land  
**CAL** Calutron  
**CAM** CAM/RPC Instrumentation  
**CMK** Com Kyl  
**COL** Col. Spgs. Walker Elec.  
**COM** Commodore I  
**CON** Contract East  
**COR** Corning Electronics  
**DAA** Dallas Avionics  
**DAL** Dalis Electronics  
**DIG** Digital Resources  
**DIX** Dixie Electronics  
**DOL** Dolphin Electronic Supply  
**DUN** Dunlap Electronics  
**EEB** Electronic Equipment Bank  
**EEC** Electronic Equipment Co.  
**EET** E.E. Taylor  
**EIL** EIL Instruments  
**ELT** Electro Test  
**EME** EME II, Inc.  
**EMS** EMSCO Div. Hammond  
**EPC** Electronic Parts Co.  
**ESI** ESI Supply Co.  
**ESL** E.S.L.  
**ESU** Electronic Supply  
**ETC** Electronic Tool Co  
**GIS** Garrett Industrial Supply  
**GOE** Gopher Electronics  
**GRA** Graham Electronics  
**HAL** Haltex Electronics  
**HAT** Hatry Electronics  
**HHS** Herman H. Sticht  
**HON** Honolulu Electronics  
**HUG** Hughes-Peters  
**HUR** Hurley Electronics  
**IDA** Idaho Instruments  
**IIV** Industrial Instrument Works  
**IND** Industrial Electronics  
**INE** Instrument Engineers  
**INI** Intermountain Instr.  
**INL** Inland Electronics Supply  
**INM** Instrument Mart  
**INO** INOTEK  
**INS** Instrumentation Services  
**ISL** Industrial Service Labs  
**ITC** ITC Electronics  
**JAB** Jabbour Electronic Supply  
**JON** Jones Electronics  
**JOS** Joseph Electronics  
**KAS** KASS Electronics Dist.  
**KAU** Kaufman Co.  
**KBT** KB Tool & Supply  
**KEM** KEMS, Inc.  
**KIE** Kiesub Corporation  
**KLA** Klaus Radio  
**LAV** Lavender Distributing  
**LEA** Leader Electronic Dist.  
**LEF** Leff Electronics  
**MAR** Marshall Industries  
**MCJ** McJunkin Corp.  
**MEM** Metermetrics  
**MES** Marsh Electronics  
**MET** Metermaster  
**MIA** Mid-West Associated  
**NCE** North Coast Electric  
**NEI** Norvell Electronics  
**NEV** Nevada Electronics  
**NEW** Newark Electronics

**NID** N.I.D.I.  
**NOR** North Supply  
**NRT** Northern Radio & TV  
**OLI** Olive Electronics  
**OLS** On-Line Int'l Inc.  
**PAL** Paloma Sales  
**PEE** Peerless Elect. Equip  
**PEL** Priest Electronics  
**PEP** Palomar Electronic Products  
**PIL** Pilgrim Electronics  
**PIN** Pioneer Instrumentation  
**PMC** Process Measurement Co.  
**PRI** Priority One Elec.  
**QUE** Quement Electronics  
**RAD** Radar Electric  
**RAG** Rag Enterprises  
**RAL** Ralph's Electronics  
**RAW** Rawson & Co.  
**RED** Redco  
**REM** REM Electronics  
**REP** Ragon Elect. Parts  
**RGB** RGB Electro-Industrial  
**RIO** Riordan Electronic Products  
**ROC** Rochester Radio  
**ROM** Rome Electronics  
**ROU** Route Electronics  
**RPS** RPS Electronics  
**RRI** R&R Instrumentation  
**RSE** RS Electronics  
**SAS** S&S Electronics  
**SCL** Sceli  
**SCO** Scott Electronics  
**SEE** Southeastern Elect.  
**SEL** Spectrum Electronics Inc.  
**SML** Standard Meter Lab  
**SOU** Southern Elect. Co.  
**SPD** Specialty Distributing  
**SPE** Specialized Products  
**SSC** Standard Supply Co.  
**STA** Stark Electronic Supply  
**STS** Scottsdale Tool & Supply  
**SUM** Summit Distributors  
**SUN** Sunshine Scientific  
**TAF** Taft Electronics  
**TAY** Taylor Elec. Co.  
**TEC** Techni-Tool  
**THX** Therm-X  
**TKS** Tool Kit Specialists  
**TOO** Tool Tronics  
**TRA** Transcat  
**TRE** Tech. Representations  
**TRI** Tri-State Inst. Lab  
**TRO** Trott Electronics  
**TWE** Trice Wholesale Electronics  
**UNI** United Radio  
**USI** U.S. Instrument Rentals  
**VAN** Vanguard Electronic Tool  
**WAS** WASSCO  
**WAY** Wayne Broyles  
**WBA** W.B. Allen Supply  
**WES** Wholesale Elec. Supply  
**WHO** Wholesale Electronics  
**WIE** Wholesale Ind. Elec.  
**WIS** Wise Components  
**WSJ** WS Jenks  
**WST** Western Elect. Supply  
**WYL** Wyle Lab Mkt. Group  
**YDI** You-Do-It Electronics  
**YIS** Y.I.S. Inc.  
**ZAC** Zack Electronics  
**ZKT** Zackit Electronics



# CALL GUIDE

Information	U.S.	International Locations
<ul style="list-style-type: none"> <li>• Product Information</li> <li>• Product Availability</li> <li>• Application Assistance</li> </ul>	Your Fluke Sales Office (See page 243) or (800) 426-0361* or (206) 356-5400	Your Fluke Representative (See page 244) WU Telex: 152385 TRT Telex: 185-103 Phone: (206) 356-5500
<ul style="list-style-type: none"> <li>• Software Development</li> <li>• Site Evaluation</li> <li>• Application Training</li> <li>• Installation</li> </ul>	Your Fluke Sales Office (See page 243)	Your Fluke Representative (See page 244)
<ul style="list-style-type: none"> <li>• Repair/Calibration Service &amp; Training</li> <li>• Service Agreements</li> <li>• Module Exchange</li> </ul>	Your Fluke Technical Center (See page 246)	Your Fluke Technical Center (See page 246)
Replacement Parts	(800) 526-4731** or (206) 356-5774 or John Fluke Mfg. Co., Inc. P.O. Box C9090 Everett, WA 98206 Attention: Parts Dept. M/S 86	Your Fluke Technical Center (See page 246)

\* 8 a.m. to 4:30 p.m. Pacific time

\*\* 5 a.m. to 4 p.m. Pacific time

John Fluke Mfg. Co., Inc.  
 P.O. Box C9090, Everett, WA 98206  
 (800) 426-0361 (toll free) in most of U.S.A.  
 (206) 356-5400 from AK, HI, WA  
 (206) 356-5500 from other countries

Fluke (Holland) B.V.  
 P.O. Box 6053, 5004 EB, Tilburg, The Netherlands  
 Tel. (013) 673973, TELEX 52237

**Litho in U.S.A.**





# A Catalog of Solutions

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**George J. Newton**  
Senior Sales Engineer

**John Fluke Mfg. Co., Inc.**

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